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California Engineering Foundation
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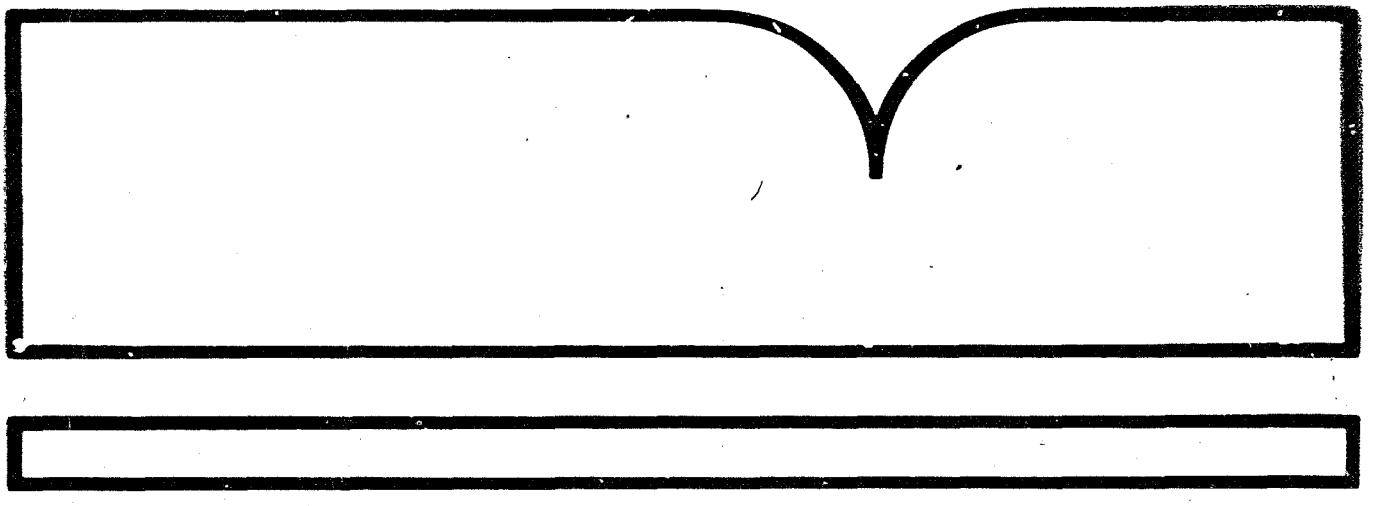

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The report summarizes the proceedings of the Forum on Federal Technology Transfer convened by the California Engineering Foundation at the NASA Ames Center, California on September 11, 1987. Over 80 representatives from industry, government, and the Federal laboratories assembled at the Forum to assist in formulating policy and implementation strategies to facilitate the flow of technology from the Federal laboratories to private enterprises, both large and small. The participants reviewed case studies of successful technology transfers and defined objectives, constraints and critical success factors involved implementing the Federal Technology Act of 1986.

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FEDERAL TECHNOLOGY TRANSFER FORUM

SUMMARY REPORT

NASA Ames Research Center
Moffett Field, California

September 11, 1987

Sponsored by:
CALIFORNIA ENGINEERING FOUNDATION

Co-sponsors:
NASA AMES RESEARCH CENTER
FEDERAL LABORATORY CONSORTIUM
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April, 1988

CALIFORNIA ENGINEERING FOUNDATION
913 K Street, Suite A
Sacramento, CA 95414
916-448-5411

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ABSTRACT

On September 11, 1987, the California Engineering Foundation convened a Forum at NASA Ames Research Center, Moffet Field, California for the purpose of exploring the nature of the technology transfer challenge. The Forum was composed of an opening plenary session with keynote speakers presenting industry and laboratory perspectives on technology transfer. Six successful transfers were presented by a panel representing firms that had benefitted by working with the laboratories. The panelists reviewed the nature of the technology transferred and the constraints that had to be resolved. Four concurrent workshops were held to develop the vision statements, identify constraints, and define critical success factors to resolve the constraints. The findings of the workshops were presented to all attendees in the closing plenary session.

This report was prepared by the

CALIFORNIA ENGINEERING FOUNDATION

by

Robert J. Kuntz
Executive Director

Editorial Assistance:
Kristen Hinchberger

CALIFORNIA ENGINEERING FOUNDATION EDITORIAL POLICY

The material presented in this report represents the product of research conducted by the California Engineering Foundation and findings and recommendations from the Forum on Federal Technology Transfer. The California Engineering Foundation, the Forum co-sponsors and the Corporate co-sponsors neither endorse nor oppose the findings presented herein, and CEF will not take a position on any public policy initiatives resulting from these recommendations nor assume an advocacy role in any legislative activities.

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CALIFORNIA ENGINEERING FOUNDATION LOGO

The California Engineering Foundation logo graphically represents the mission of the CEF. The blank circle depicts fire; the circle with the horizontal line depicts water; the circle with the cross depicts land; and the circle with the dot represents air.

These historical symbols were used by early peoples to describe the four elements perceived to control life on earth. Although modern humankind is now aware that their lives and environs are much more complex and interrelated, the ancient challenge remains the same: how to exist within the framework of the elements; how to live, prosper, and have perpetuity on planet earth in light of the growing knowledge of technology and the burgeoning demands now made on limited resources and the environment.

The quest of science has always been to unlock the secrets of the natural world and to understand the principles which govern the physical environment. The future mission of engineering and technology will be the application of these principles in such a way that interaction of the earth's people with their environment is benign.

PRODUCTION CREDITS

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EXECUTIVE SUMMARY

Historically, the United States government has sought to develop mechanisms for transferring its technology to the private sector for increased utilization. This goal is still a fleeting target. As the nation reexamines its position in a highly competitive world market, greater attention has been given to maximizing the benefits to be derived from the over $60 billion that the federal government spends each year on research and development. Much of that research is devoted to military and space missions, but the potential spin-off technology for commercialization or use in the private sector is virtually untapped. International trade deficits, budget deficits, growing national debt, and the need for increased dedication to cooperative endeavors between government, industry, and educational institutions are some of the policy forcing functions.

Of the $60 billion in federal dollars spent for R&D (about one-half of the total U.S. public and private commitments), about $20 billion is spent in the 700 large and small federal laboratories conducting research for 13 federal agencies. Statutory missions for the different agencies vary, but the transfer of technology from the federal sector to the private has been ancillary to most. NASA has a mandate to transfer its technology as part of its original statutory mission. Some of the other agencies have incorporated program directives to accomplish this objective. For example, the Space Defense Initiative program in the Department of Defense has a technology transfer office specifically dedicated to the cause.

In 1980, Congress passed the Stevenson-Wydler Act as a formal means for increasing the dedication of all federal agencies to the technology transfer mission. Though a step in the right direction, the law did not cause a ground swell in technology flow. Later, a commission, headed by David Packard, was appointed by the President to examine the challenge once again. The commission made recommendations which were translated by Congress into new legislation, called the Federal Technology Transfer Act, which was passed and became law in January 1987. President Reagan included the Act in his state of the nation address and subsequently issued an Executive Order in April 1987 that further clarified actions to be taken to implement the new law.

The California Engineering Foundation provided technical input, on request, to Congressional staff when the enabling legislation was in Congress. After passage, the CEF determined that it could play a leadership role in the implementation of the act by creating a neutral ground to examine the constraints and impedances that exist in the public, private, and educational sectors to the implementation of the new law. The Foundation's approach was to first "scope the problem" and use the finding to develop a strategic plan, on a pilot project basis, that would be national in scope but conducted on a regional basis to facilitate logistics. The CEF established a national task force made up of key individuals representing the public and private sectors. The Foundation appointed a member of its Board of Directors, Dr. Joseph Longo, Vice President and General Manager, Science Center, Rockwell International to chair the task force.

The task force met in June 1987 and determined that a forum should be convened to begin the process of strategic planning. One of the objectives would be to develop vision statements, identify constraints and impedances to the implementation of the Act, and develop critical success factors that would be the basis for strategic success. The task force also recognized that there were no "quick fixes," since the challenge was very complex and required significant changes in all sectors.

The Foundation convened the Forum on Federal Technology Transfer at the NASA Ames Research Center on September 11, 1987. Over eighty representatives from industry, agencies, and the federal laboratories assembled to assist in formulating strategic plans.

The Forum was composed of an opening plenary session with keynote speakers presenting industry and laboratory perspectives on technology transfer. Six successful technology transfers were presented by a panel representing firms that had benefitted by working with the laboratories. The panelists reviewed the nature of the technology transferred and the constraints that had to be resolved. Four concurrent workshops were held to develop the vision statements, identify constraints, and define critical success factors to resolve the constraints. The findings of the workshops were presented in the closing plenary session to all attendees. Subsequently, the Economic Development Agency of the U.S. Department of Commerce awarded CEF a small grant to assist the foundation in documenting and disseminating the results of the Forum.

GENERAL FINDINGS

The keynote speakers provided insight into the nature of the challenge from their perspectives. There was unanimity in the need for action and recognition that the challenge ahead would be very difficult and require dedication in both the public and private sectors. The consensus was that the status quo is not a viable option and that significant changes in attitude in federal agencies, their laboratories, and in the industrial sector were crucial to the implementation of the new law. There was

also recognition of the tremendous potential that exists in the laboratories to assist American industry and entrepreneurs in becoming more competitive in the world market and concern that in the past foreign competitors have capitalized on American ingenuity left fallow by the nation's public and private sectors.

The U.S. Patent and Trademark office reports that the federal government and educational institutions combined represent only about 1-1/2% of the patents filed in 1986. About 46% of all the patents issued were of foreign origin, therefore, about 3% of the domestic patents reflected the patent activity resulting from over $60 billion in federally sponsored R&D; and to this must be added the public and private sector research funded in educational institutions across the nation. Although patents of origin are only one indication of innovation, the numbers are startling just the same.

Policies affecting the transfer of technology from the public to the private sector were established by statute, Executive Order, and agency regulations. Previous philosophy held that what was paid for with tax dollars should be owned by the government and made public domain. However, what everyone owns, no one will invest in to carry the technology through the innovation process to the marketplace. The new policy permits the federal laboratories to negotiate exclusive rights to technology with private firms and share in any royalties that may be derived from the technology utilization. Provisions are also in the new law to grant royalty sharing with federal workers responsible for inventing and innovating the technology.

The Forum workshops addressed the challenge from four perspectives:

- Industry Needs and Laboratory Capabilities
- Personnel and Resource Constraints
- Legal, Policy, and National Security Constraints
- Laboratories and Industrial Motivation

Public Law 99-502 goes a long way at correcting structural impedances to the transfer of federally owned technology to the private sector. The Presidential Executive Order of April 1987 takes the next step. However, the challenge is great and the inertia of the federal system is massive. In addition, attitudes that exist in both industry and the government need to be modified to create a positive motivation in both sectors to increase the efficiency of technology transfer. The most effective means of transfer is through people interaction, in fact, technology transfer is a "body contact sport."

Motivation was identified as a key factor in facilitating the implementation of the new law. Federal agencies must delegate responsibilities to their laboratories to establish formal relationships with private sector firms and execute formal transfer and exclusive licensing arrangements. Laboratories must provide formal incentive systems at all levels so that technology transfer becomes a priority element in their missions and a matter of promotion and recognition for supervision and administrative personnel. Industrial firms must reevaluate their own methods of operating to set aside the "not invented here" syndrome and explore the plethora of potential solutions that exist in the public sector for unresolved problems.

The technology in the laboratories is diffuse. Entrepreneurs who are exclusively looking for ready-made "widgets" to take to the market may be disappointed. However, intellectually curious engineers and scientists in industry who are seeking to aument their "bag of tricks" with potential solutions to problems will find a gold mine. Technology developed in a Department of Transportation laboratory for highway bridge construction could provide solutions to long-term corrosion of microelectronics circuits. Instrumentation developed to examine particulate matter in a combustion process may be applicable to the manufacture of glass fiber for photo-optical circuits. Networking and cooperative interaction will be the name of the game.

RECOMMENDATIONS

Because of the complex nature of the technology transfer process and multiplicity of federal laboratories and the potential industrial users of the technology, the need for coordination becomes essential. The California Engineering Foundation was identified at the Forum as a potential entity to provide the coordinating function. CEF is willing to serve in this capacity, and the level of effort to accomplish the objectives will be determined by the level of commitment and support that CEF receives from public, private, and organizational sectors.

Actions needed in the public sector include: classification of generic technologies in a standard format and communication of laboratory capabilities to potential users of the technology; development of uniform legal documents for exclusive licensing of intellectual property; creation of motivational techniques to stimulate researchers and administrative staff; enactment of uniform regulations to provide a common base for industrial involvement; and modification of federal statutes, where necessary, to solve administrative and structural impedances in the transfer process.

Actions needed in the private sector include: creation of educational programs to alert industry and potential entrepreneurs about the strategic technology transfer process; development of new corporate policies that welcome externally developed technologies and counteract the "not invented here" syndrome; achieve a consensus on industry-wide technology classification systems to facilitate standards for documenting technologies in ways that meet the needs of industry and other users; adopt incentive policies that recognize technology transfer as a high priority activity for industrial technical staff; and assign specific job responsibilities with allocated budgets to facilitate the technology transfer process.

ACTION PLAN

The California Engineering Foundation has been asked to and is willing to play a national and state leadership role in the implementation of Public Law 99-502. The results of the Forum will be translated into an action plan with counsel from the CEF task force. In order to carry out the tactical program, the CEF must have the functional capability in funding, human resources, and in-kind services. Funding and in-kind services should come from industry, federal laboratories, state economic development and commerce offices, and federal agencies.

Motivation was identified as the principal forcing function that will influence actions for implementation of the new law. The public sector has a mandate to "push" the technology flow to the private sector. Grants and contracts are mechanisms through which the agencies and laboratories could support the CEF program. Private industry has an incentive to obtain new technologies that have been developed under public funding, and increasing the availability of this technology improves firms' competitiveness. Firms could support the CEF program through membership in the CEF and support grants from their foundations.

The rate of development of the action plan and the implementation of tasks will be directly related to the level of support that the Foundation receives from all sources.

PREFACE

The ability of the United States to compete effectively in the global market directly affects the nation's standard of living, quality of life, and sovereignty. There are many influencing factors encompassed in the term, "competitiveness," which include: trade deficit, investment deficit, budget deficit, national debt, personal debt, interest rates, product quality, currency exchange rates, and relative productivity. From a macroeconomic perspective, all of the above are either causes, symptoms or resultants.

The cause of the decline in the U.S.'s relative competitiveness can be debated extensively. However, it is more important to have a clear understanding of what actions must be taken to increase the standard of living, protect the quality of life, and ensure the nation's sovereignty. To accomplish this objective, the total capabilities of the country must be mobilized. Crucial to this effort, and thoroughly entwined with every aspect of the economy, is the effective use of science and technology — the fuel for the engine of economic development and progress.

A simplified prescription to cure the nation's competitive illness includes the application of science and technology to the development of useful high-quality products, at market competitive prices, through high value-added industrial processes, backed by reliable post-sales services. This prescription presumes that the nation will rediscover its manufacturing excellence that made it world renowned. It is through this process that the country will increase its intrinsic wealth and capitalize on its *in-situ* capability.

The science and technology capability of the U.S. is embodied in the educational, industrial, and governmental sectors. Educational institutions conduct basic research which is targeted on extending the frontiers of fundamental principles in the physical, biological, and mathematical sciences. Industrial technology usually focuses on near term needs for the product and process development. A major source of technology that has been overlooked by the nation's industry is that developed in the federal laboratories which focus their efforts on specific missions.

The federal government invests about $60 billion a year in research and development. Thirty percent of these funds are allocated to the federal agencies which oversee nearly 700 large and small research and development laboratories. Private sector industry invests about $60 billion in research directly or through special programs funded in educational institutions.

The history of federal technology management as related to technology transfer in the United States is filled with disappointment. Statute, regulation, executive order, publication, and diffusion have been but a few of the techniques employed. NASA was mandated under its enabling statute to transfer its technology on a nonexclusive basis. President Nixon issued an Executive Order to provide exclusivity for private innovators who license federal technology. The Stevenson-Wydler Act expanded federal policy to grant educational institutions and nonprofit organizations the right to obtain exclusive rights in technologies developed under government funding. President Reagan appointed the "Packard Commission" to conduct investigations to determine why the 1980 act did not achieve its objectives.

The results of the Packard studies were embodied in legislation introduced into Congress in 1984 which created the Federal Technology Transfer Act of 1986 that became law January 1, 1987. The White House issued an Executive Order in April 1987 calling upon federal agencies to implement the Act.

The new Act is a breakthrough in several areas. It provides for a high degree of autonomy in the laboratories for establishing relationships between the labs and industry, grants royalties to federal inventors, and creates the basis for exclusive licensing of inventions to private firms. However, the Act does not provide the administrative mechanism to ensure its implementation.

The California Engineering Foundation has been actively involved in the broad spectrum of activities related to industrial development and technology transfer since the Foundation was established in 1974. In addition, CEF studies related to the competitiveness and economic development challenges have received international recognition. CEF was called upon to provide technical input to Congress when the Federal Technology Transfer new Act was being developed. The CEF has now taken the initiative to examine the present environment for implementation of the Act. Using the scientific method, the CEF has suggested the ideal state or vision of the future, defined the potential constraints to achieving the vision, developed strategic critical success factors needed to obtain maximum technology flow from the federal laboratories to the private sector.

The September 11, 1987, Federal Technology Transfer Forum was the first step in the CEF's strategic plan. Findings from the CEF research, together with those of the Forum, constitute the basis for developing and executing an action plan. This report embodies the product of the Forum and becomes the basis for the path forward.

The future of the nation's standard of living, quality of life, and sovereignty will be set by decisions made and actions taken by all sectors in the coming years. One major element in this process must be the efficient management of the nation's engineering, scientific and technological resources including the national wealth embodied in the federal laboratories. It is to this end that the California Engineering Foundation has dedicated its efforts at both the state and national levels.

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KEYNOTE PRESENTATIONS

The Forum on Federal Technology Transfer began with presentations made by representatives of federal laboratories and industry.

The objective of these presentations was to set the scene for the subsequent deliberations of four concurrent workshops addressing the constraints and critical success factors related to the implementation of the Federal Technology Transfer Act of 1986.

This report provides the essence of the speaker's thoughts in a journalistic format.

The following were the keynote speakers:

Dr. Joseph T. Longo, Vice President and General Manager, Science Center, Rockwell International Corporation

Dr. William F. Ballhaus, Jr., Director, NASA Ames Research Center

Michael L. Bandler, Vice President, Network Engineering and Planning, Pacific Bell

Gordon Longerbeam, Project Leader, Technology Transfer, Lawrence Livermore National Laboratory

Joseph W. Martinelli, General Manager, Engineering Technology Department, Chevron Corporation

KEYNOTE PRESENTATIONS

DR. JOSEPH T. LONGO

Dr. Longo opened the Forum with a welcome to the attendees and expressed appreciation to the co-sponsors. "We are grateful to NASA Ames Research Center for providing the facility and assistance to make this Forum possible," Dr. Longo said. "It is fitting that this Forum be held here, because NASA has been at the forefront in the transfer of Federal Technology to the private sector."

Dr. Longo informed the group that the California Engineering Foundation has had a strong interest in technology transfer since the Foundation was established in 1974. He said that CEF provided technical input to key staff members of Congress when HR 3773 was moving through the legislative process which resulted in the creation of the Federal Technology Transfer Act of 1986. "We have elected to take an active role in the implementation of the new Act, because of its importance to economic development and competitiveness. As a consequence, we have established a national task force," said Longo.

Dr. Longo said that the Task Force mission is to develop and implement actions which will increase the efficiency of utilization of federally owned technology, facilities, and human technical resources in the private sector in order to improve the competitive position of the United States in the world market. "The Task Force has representatives from major industrial firms, the Federal Laboratory Consortium, several federal laboratories, the U.S. Department of Commerce, the White House Office of Science and Technology Policy, the Industrial Research Institute, and the American Electronics Association," Longo pointed out to show the demographics of the group.

"This Forum is the first major step of the Task Force," Longo said. He continued by quoting Dr. Eugene Stark, Chairman, FLC, concerning his expectations of the Forum, "Prepare an agenda and action items to be reviewed by California Federal Laboratory directors and by CEO's of major industrial firms and small firms at the cutting edge of technology."

The challenge ahead in implementing the intent of the new Federal Technology Transfer Act is complex and difficult. There is no panacea. Dr. Longo pointed out that the presence of a third party to assist the process of technology transfer is critical to any success. "The California Engineering Foundation can provide a means to increase the effectiveness of the laboratories and industrial firms by augmenting their activities and creating a third party that acts as a bridge and/or facilitates networking," said Longo. He also said that the product of the workshops would be important in determining the role that CEF would play in the future. He said that CEF is a non-profit corporation created on behalf of the technical community — industry, government, and educational sectors, and reliant on grants and donated in-kind services to conduct its activities.

"My boss, Bob Cattoi, who is the Senior Vice President of Research and Engineering for Rockwell International, believes that successful technology transfers are characterized by a continuous flow, back and forth, of people, ideas, and other resources as opposed to discrete one-way transactions in which there is a sender and a receiver, a them versus us mentality," Longo reported. "Let this meeting be the first step in a continuously fruitful interchange between federal laboratories and industry in the state of California — an interchange in which we all profit by working together for a stronger U.S. competitive position in the world marketplace," he concluded.

KEYNOTE PRESENTATIONS

DR. WILLIAM F. BALLHAUS, JR.

"The NASA Ames Research Center has the largest R&D budget of any organization in Silicon Valley. We're the sixth largest high tech firm in the Valley," said William F. Ballhaus, Jr. in his introductory remarks to the over 80 participants in the Forum.

"Developing technology is only half of our mission. It's worthless unless somebody picks it up and uses it," Ballhaus continued. Dr. Ballhaus said that getting technology out of the laboratory and into the hands of the people who are actually going to use it is a very difficult task. "It takes a lot of nurturing and hand holding, and you've got to bring the user to the incubator and really work with him very carefully."

Ames Research Center has two sites in California, one at Edwards Air Force Base near Lancaster, and the other at Moffett Field near Mountain View. The facility at Moffett Field was founded around 1940 as a West Coast aeronautical laboratory. The primary concern was to have an alternative to Langley Research Center (the first NASA center) on the East Coast which was considered to be vulnerable to attack from Europe during the second world war. The mission of NASA Ames is to develop technology that can be transferred to the large manned space flight centers — Marshal, Johnson, and Kennedy.

Dr. Ballhaus mentioned some recent up-grades to the facility. "We've just built the Fluid Mechanics Lab, the Numerical Aerodynamic Simulator (NAS) building, and now we will begin construction early next year of a Human Performance Research Laboratory. We will put in mockups of the Space Station and begin to integrate hardware into those mockups." Earlier in the year, Dr. Ballhaus hosted an open house for technical policy leaders throughout the nation to dedicate the new supercomputer capability that the Center obtained which permits very accurate simulation of aerodynamic phenomena and permits mathematical modeling and extrapolation of results from full scale wind tunnel tests for advanced designs.

Dr. Ballhaus described the broad strategic mission of the center and said that they have just completed their long range plan. "One of the principal areas that we're going to pursue is humans in space. I approach it from a historical perspective, looking forward 100 or 200 years, and try to anticipate what the history books will say about this small period of time," he said. "The historians may say that this era was significant because it's that unique point in man's history where he changed from the status of visitor in space to a permanent resident of space. And by the end of this century we will have a permanent human presence in space, if we don't have one already. The Russians claim that they are going to permanently man their space station," he observed.

Director Ballhaus then reviewed other aspects of their mission plan which includes the integration of some disciplines at the Center, such as, the aeronautical human factors for applications in space; command and control expertise; and artificial intelligence. He said that these will be synergistically combined to take an overall systems look at a human in the loop and to increase the reliability of systems to make them "human error-tolerant" and as productive as possible.

The group was spellbound as Dr. Ballhaus provided an overview of research activities taking place at the Center. He displayed special pride with the Numerical Aerodynamic Simulator (NAS) and contrasted the techniques required ten years ago to conduct aerodynamic analysis with the approaches now possible using the Cray 2 computer. It was as though science fiction had suddenly become reality. Many industrial firms have a strong independent attitude and don't rely on anyone else to provide facilities they need for new product development. Dr. Ballhaus referred to experiences with the Boeing Airplane Company as an example of an industry initiated technology transfer approach. "Boeing uses our facility for computational simulations applied to advanced aircraft research. They also send their computer people to our Center to examine our analytical systems and then take the technology back to Boeing and replicate it. Boeing's approach has been to follow our technology, let us take the risks, and then, if we succeed, they incorporate our methods into their operational systems," he said.

Dr. Ballhaus spoke of the artificial intelligence program which is targeted on relieving astronauts of a tremendous amount of housekeeping. He described other programs being conducted in the Center related to the space station design and operation, tilt rotor aircraft, vertical lift off and landing jet aircraft, and short take-off and landing aircraft that can be used in commercial air transportation.

"We produce a tremendous amount of technology here," he said. "One of the difficulties is disseminating that technology," he continued. The enabling legislation that formed NASA in 1958 specified that the Agency "provide for the

widest practicable appropriate dissemination of information concerning its activities and the results." In light of their mandate, Ballhaus said, NASA Ames publishes over 750 papers a year and interacts with over 200 colleges and universities and a number of industrial co-venturers. The Center has an office of Commercial Programs which has two objectives: (1) to establish a close working relationship with the private sector and academia in order to encourage investment in and the use of space technology, and (2) to facilitate private sector space activities through the use of available government capabilities.

Dr. Ballhaus showed the group a schematic that demonstrates the flow of technology from the public to the private sector. "Our principal method of dissemination is by publication — we publish a tremendous number of papers. The next most effective form is through people. Our people present papers, then interact with people from industry at conferences where a large amount of technology gets transferred on the back of a bar napkin," he said. The informal process seems to be the most effective, according to Ballhaus. "We have a program called Industry Research Associates Program where, if we have a joint interest in a particular project, industry will send somebody here at their expense, we'll provide computer or wind tunnel time and office space, and we'll work jointly on the problem."

An example was given of a successful transfer program with Rockwell International in 1975. "People from Rockwell came here, and they were desperate. They wanted time in the wind tunnel to solve a problem in an aerodynamic development they were doing. In discussions with the Center staff, it became apparent that the problem could not be solved under Rockwell's time constraints and offered that a computational approach be used," recalled Ballhaus. "One of the key ingredients in technology transfer is desperation, and they were desperate." The final result was that Rockwell sent technical personnel to work with Dr. Ballhaus for about a month to learn how the computer code worked, and to modify it to meet their particular geometrical requirements.

"What happened? Our computer code received industrial recognition, because it saved a program, and that was the first evidence of payoff in the massive investment that NASA had made in computational fluid dynamics for the previous six-year period. It was a milestone in terms of our research program. From the company's standpoint, they now had a new technology that they could use in their arsenal for aerodynamic design," Ballhaus observed. The process was responsible for the training of a Rockwell expert in the field of computational analysis who then seeded the company by training other people to use the technology. "That's a device that we use quite effectively to transfer our technology," said Dr. Ballhaus.

The final means used by the Center to transfer technology is through products. Dr. Ballhaus gave two examples of highly successful transfers:

(1) A device was developed to test stiffness in astronauts' bones to determine the level of osteoporosis that occurs in space. It is now marketed as a commercial product in the medical field.

(2) A compound was developed for use as an anti-scratch membrane to coat the visors for space suits. The technology is now being used to coat sunglasses. The sunglass manufacturer, Foster Grant Company, has realized sales of the new product in excess of $75 million.

Dr. Ballhaus summed up his remarks, "Every year we compile a list and description of some of the spin-offs from the space program. The book is called SPIN-OFF and it's fun to read through it every year and see the use of portable x-ray machines to look for injuries in accident victims and football players — all the many things that come out of technology originally developed for aerospace applications."

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KEYNOTE PRESENTATIONS

MICHAEL L. BANDLER

"Our state and country face an extremely complicated and perplexing challenge: competitiveness. This term is in danger of becoming a buzzword, but let me remind you that early in 1985, a blue ribbon Presidential Commission documented why the United States must preserve and improve its competitive edge," Michael L. Bandler, Vice President of Network Engineering and Planning, Pacific Bell, told the Forum attendees. Bandler pointed out the relationship between competitiveness and the importance of the transfer of federally owned technology to the private sector. A new law became effective January 1, 1987 (the Federal Technology Transfer Act of 1986), and President Reagan targeted the subject in his remarks in two formal ways during the year. "President Reagan saw fit to speak of the transfer of federally owned technology to the private sector for commercialization in his 1987 State of the Union Message and in a strongly worded Executive Order issued from the White House on April 10. These statements made it unmistakably clear that the President wants all federal agencies to cooperate in the drive to, as he put it, "keep the United States on the leading edge of international competition," Bandler said.

President Reagan said in his Executive Order, "It is important not only to ensure that we maintain American preeminence in generating new knowledge and know-how in advanced technologies but also that we encourage the swiftest possible transfer of federally developed science and technology to the private sector."

The California Engineering Foundation had not grappled with this problem for long before it concluded that there is no quick fix, and a long-term strategy is essential, according to Michael Bandler who serves as the Foundation's President. "Indeed, the private sector's focus on the quarterly bottom line and near-term results is a large part of the problem," Bandler observed. "As the CEF sees it, a partnership must develop between industry, government, and education. We have to work together, pool our ideas and know-how, and focus our research and development energies," he stated. Greater use of the nation's wealth in federally owned technology is a crucial element in the equation according to Bandler.

Mr. Bandler discussed the Foundation's publication on strategic planning for competitiveness. "Three weeks ago, the CEF released its CALIFORNIA MASTERPLAN FOR ECONOMIC DEVELOPMENT AND COMPETITIVENESS," he said. "This Forum is very much a part of the long-range strategy." He referred to one of the critical success factors presented in the Master Plan document which reads:

"The Federal Laboratories should respond effectively to the mandate of Congress ... and establish close working relationships with the private sector to effect technology transfer. Private industry should articulate its needs to the laboratories to create both a "push" and a "pull" to obtain increased use of new technology developed under federal sponsorship."

"This is a most appropriate setting for this Forum, since California is by far the largest recipient of federal research and development funds. NASA has pioneered in sharing the fruits of federal R&D, and Ames Research Center is one of NASA's crown jewels," Bandler stated.

NASA may not have been first with Federal Technology Transfer, but it has been prolific. "I keep my sinuses clear with Actifed, a compound developed for space flight to alleviate some of the nasal problems experienced by the Astronauts," said Bandler, referring to a specific transferred technology. He went on to mention several other spin-offs from the space efforts at Ames, such as ball point pens originally designed to function in zero gravity that will write upside down, plastic sunglasses that won't scratch, and an invention called "Cool Head" which is a helmet and vest with built-in water cooling for potential use by miners and fire fighters.

NASA has had a statutory mandate to transfer technology since its inception and thus has been the exception among federal agencies. Bandler pointed out that the yearly federal investment in research and development accounts for about half of the $110 billion the nation spends on research and development in the public and private sectors combined. "Yet only about one and one half percent of the over 80,000 patents (of which about 50% are of foreign origin) issued in the U.S. every year stem from federal and educational institution research combined," observed CEF President Bandler. "Of these, only roughly 150 have been finding their way into commercial application. From these and earlier patents, the Treasury has been taking in about $1.6 million yearly which

represents a 0.00032% commercial return on the $55 billion of yearly federal expenditure," he observed.

President Bandler expressed concern for the decaying state of technology in the U.S. and the growing impact that this has on the nation's international trade deficits. "Evidence abounds as to the effectiveness of our international competitors. We once were dominant in complex consumer electronic products, now we've been run off the field. The development and manufacture of fiber optics is led by Japan, and in industry after industry, we have lost either the preeminence we once enjoyed or large chunks of market share." He examined some of the factors that have swung the competitiveness pendulum to the U.S.'s international competitors, including lower labor costs, a focus on quality, and the close support that their industry receives from their governments. In the latter, Bandler said that some governments have provided product subsidies, assisted in central planning, rigged trading rules to help the home team and hurt competitors, and in some cases violated the general world standards for protecting intellectual property rights. "We have some advantages, too," Bandler stated. "Innovation has been our strong suit — creating advanced technology, our free enterprise tradition goes with innovation, and voluntary association. We also have a magnificent set of tools in the federal research establishment."

Even before the crisis in competitiveness had reached today's intensity, the central issue was captured well by the Federal Laboratory Review Panel, created by the White House Science Council and headed by David Packard. The Panel's report to the White House in 1983, said in part: "The United States no longer can afford the luxury of isolating its government laboratories from university and industry laboratories."

"The ultimate purpose of federal support for R&D is to develop the science and technology base needed for a strong national defense, for the health and well-being of U.S. citizens, and for a healthy U.S. economy. Federal laboratories should recognize that they are an important part of the partnership with universities and industry in meeting this goal. A strong cooperative relationship must exist between federal laboratories, universities, industry and other users of the laboratories' research results." The Packard report went on to note that the federal labs perceive industry as "an awkward partner with a different value system." Bandler feels that there are grains of truth in that perception but that opportunities must be vigorously sought to develop means of getting industry and the labs to work together for the good of both and the nation as a whole. "Why is industry interested in federal technology transfer? For one reason! Research and development is very expensive," Bandler stated.

Mr. Bandler compared the successful relationships that have evolved between universities and industry and what should happen between the federal laboratories and industry. "There is a shining example, clearly visible a few miles from the NASA Ames Research Center, at Stanford Research Park on the campus of Stanford University." He alluded to the birth of some of the most powerful and creative firms (such as Hewlett Packard) that had their beginning at Stanford. "Successful partnerships exist today all across the country in which cooperative efforts have produced significant results and yet protected the vital interest of both," Bandler stated.

Bandler expressed that similar cooperation by the federal laboratories with industry, other government levels, universities, and nonprofit institutions holds promise of major gains. "We can save time and expense; we can focus on areas of potential new productivity; we can bolster our national prestige," Mr. Bandler predicted.

There have been several attempts made by the federal government to increase the use of federally owned technology prior to the passage of HR 3773 in 1986. The Stevenson-Wydler Technology Innovation Act of 1980 was the first omnibus legislation in the field since the formation of NASA in 1957. Earlier, President Nixon issued an Executive Order that provided for exclusivity in the transfer of federally owned technology to private firms.

The 1986 Act amended the Stevenson-Wydler Act and opens many doors that were still locked in the previous statute and regulation. It establishes policy to transfer technology from all federal laboratories and even permits laboratory directors wide powers to execute licensing agreements with private industry. It offers 15% royalty incentives, up to a maximum of $100,000 per year, to federal inventors responsible for new technology which is successfully transferred. It requires that each laboratory director take technology transfer into account in evaluating and promoting employees.

"A noteworthy feature of the law is its arming of laboratory managers with discretionary funds and the authority to invest them in innovative activities," Bandler continued. "The Executive Order that President Reagan issued April 10, 1987, charges each Cabinet Officer and each agency head with encouraging and facilitating collaboration with potential partners in sci/tech research."

Bandler expressed concern that President Reagan, like Congress, did not make any great commitment of money, or its equivalent, to assist in the implementation of the new Act. The Executive Order does enable the departments and agencies to support the technology transfer effort within their ordinary budgets and provides a small

amount of funds to the Federal Laboratory Consortium. There is a debate developing in some of the agencies affected by the new law as to what portion of their budgets should be used to determine the specific contribution to support PL 99-502 (Federal Technology Transfer Act of 1986) activities. Everyone is counting on the lab directors and researchers to create a revenue stream that will pay for future activities.

Bandler also wondered about the future level of commitment of the U.S. Department of Commerce to the federal technology transfer effort. He stated that Malcolm Baldridge, past and deceased Secretary of Commerce, was dedicated to the cause. "I want to pay tribute to the late Malcolm Baldridge. This law assigns key duties to the Secretary of Commerce, and I hope his successor, C. William Verity, Jr., will continue the leadership shown by Mr. Baldridge in this extremely important field."

One of the objectives of the Forum was to identify industry constraints to technology transfer. "One obstacle is industry's own attitude, or the attitudes of certain segments of industry. We are all aware of Detroit's arrogance before German and Japanese automakers taught us some painful lessons; it was a form of know-it-all, very unwarranted arrogance," lamented Bandler. "Then there is the "not invented here" syndrome, which is a kind of arrogance but which also has roots in the guarding of proprietary information," he continued.

Some industrial leaders shun collaboration out of fear that their trade secrets may be disclosed. Negotiated agreements can preserve essential privacy, but this attitude must soften in view of the challenge the nation faces. "You haven't much privacy when your pants are being beaten off," remarked Bandler. "If industry views the new Act as a new opportunity and thinks creatively about how to use it, progress can be enhanced. We can turn loose some unbiased, entrepreneurial, young private sector technology hunters and offer them rewards for finding federal technology to transfer and adapt."

Bandler also expressed concern over the possible bureaucracy constraints that can create problems when people at headquarters don't see eye-to-eye with the people at the laboratory.

The Scientific American magazine noted that between October, 1977, and December, 1985, the DoE received 135 waiver requests for patent rights to inventions made at contractor-operated facilities. By Christmas Eve, 1985, the DoE had completed action on only 55 of the requests; five had awaited a decision for more than two years.

At the Sandia Laboratory in Albuquerque, a device was developed that improved on the traditional "bridge wire" (semiconductor bridge that behaves like a fuse on a chip) for initiating explosions. At the New Mexico Institute of Mining and Technology at Socorro, there is a Center of Excellence in Explosives, funded by the state. Experts at the Center wished to develop the semiconductor bridge, and Atlas Powder and other companies were interested in investing in it. To enable that to happen, the DoE needed to waive its patent to Sandia Lab in order that an exclusive license would be granted to the experts' small business, which then could proceed with development of a number of potential commercial applications. The matter has awaited action for more than a year (a very slow response by industry standards) during which time DoE raised objections about export control — a matter best left to the manufacturing company and the U.S. Department of Commerce, or another office in the federal government that deals with export controls.

Bandler mentioned some other impedances to tech transfer, "Jealousies and turf battles occur not only within agencies but also between them. Competition for funds is fierce. There is the drag of federal regulatory activities. One federal body may block what another encourages."

Exclusivity is another consideration. In the past, policy makers felt that what the federal government paid to develop was in the public domain and that no single firm should have exclusive rights to develop and reap the profits from technology developed "at taxpayers expense." This policy gave rise to the phrase, "everybody's property, nobody's product."

"I am aware that there were some cases in which nonexclusivity worked," Bandler observed. "At Sandia Lab, a new photoresist used in the fabrication of microcircuits was developed. When illuminated by ultraviolet light, it vaporizes, eliminating one whole step in fabrication. The DoE, as patent holder, offered this advance on a nonroyalty, nonexclusive basis, and a number of firms are now using it." Bandler was quick to point out that this invention required no further development, and therefore industry was not required to invest venture capital to innovate the invention as is usually the case for other technologies. "Usually a patent or invention requires considerable development work to make it commercially viable. It also requires a marketing effort, and federal agencies are passive marketeers at best," stated Bandler.

The lack of channels of communication was cited as a further impedance by Bandler. "The Federal Laboratory Consortium is an admirable outfit. It sprang up much as the California Engineering Foundation did, meeting a perceived need through volunteer effort. The new law formally charters FLC, and I hope that it works well." The jury is still out, as previously mentioned, as to whether FLC will receive the funding level needed to carry out its new mission.

Excellent informative materials are being produced by FLC, and Bandler advised industry representatives to take advantage of their availability. He said that the Consortium offers a clearinghouse function for research requests, but limitations in funding require care to screen requests for proper targeting. Industrial firms were urged to use the basic procedures for gathering information on federal technology, and then to request special customized help only when no other course of action is available. There is no norm for characteristic laboratory behavior in the dissemination of information. Some labs are mute and others are loquacious, depending upon many variables. The National Technical Information Service is an excellent screening source of federally owned technology.

After mentioning additional factors of consideration, constraints, and other obstacles to the implementation of the new technology transfer Act, President Bandler focused on the term impedance. "Impedance is a precisely defined electrical engineering term, and the parallel here is cogent. It is a measure of total opposition combining resistance and reactance. I hope our obstacles are not that awesome," Bandler told the group. "Perhaps we should remember in Latin the root verb. to impede, means to hold by the feet. Wasn't it Confucius who said, "He who holds another person by the feet is liable to get kicked in the teeth?" he quipped.

"There is a need to broaden this area of technology transfer and cooperation in research and development efforts; and we have the opportunity afforded by the new law and the President's support. We have some potential problems that we know from the start," Bandler said. He then said that the resolution of the problem depends upon collective wisdom, pooling of ideas, and involvement of colleagues and counterparts in the process of consensus building. The tasks must be prioritized.

Looking at the path forward, President Bandler summed up his remarks by focussing on the role of California in showing the way. "California has 36 federal laboratories, including some of the biggest and most respected in the nation. Our state has 22% of America's scientists and engineers. We are not lacking for critical mass. We are positioned to deal with this opportunity. We have a track record of cooperation in addressing the competitive challenge," he stated.

President Bandler then offered the offices of the CEF as a coordinating entity in the U.S. "The California Engineering Foundation has taken the lead in fostering this cooperation, and top officials from some of the federal laboratories in California have taken part in our deliberations. The Senate/House Conference Committee recommended the concept of regional advisors for the Federal Laboratory Consortium, although it did not write formal advisory committees into the law. If in its wisdom, the FLC decides it needs an advisory committee, the CEF stands ready to do all it can to fill the bill. We are better deployed than any other California group that I know of to undertake such a task and to help mount demonstration projects," he offered.

"So, the opportunity is at hand, the time seems ripe, and our resources are extensive. As a watchword for the day, I'd like to close by quoting a few familiar lines from William Shakespear's JULIUS CAESAR:

> "There is a tide in the affairs of men,
> Which taken at the flood, leads on to fortune;
> Omitted, all the voyage of their life
> Is bound in shallows and in misery."

Let's ride this flood tide," Bandler concluded.

GORDON LONGERBEAM

"Before 1980, federal technology transfer used, predominantly, a public domain approach. There is a shift in policy, and a more proprietary approach is being employed," said Gordon Longerbeam, Project Leader, Technology Transfer, Lawrence Livermore National Laboratory. The Lawrence Livermore National Laboratory, one of the three U.S. Department of Energy laboratories managed by the University of California, has developed patents on new areas of technology, and there is a desire to move this technology to private sector industry. "This will require proprietary protection to stimulate industry's investment in the innovation process. I think that this approach will be the theme for the next few years," Longerbeam continued.

"The best means for effective technology transfer is through close personal interaction. This is not to say that published papers and meetings are not important, but the people-to-people mechanism is the most effective," Longerbeam stated. Technology transfer will complement not erode the basic mission of the laboratory, since the laboratory infrastructure is strengthened through the interactions.

The Los Alamos Scientific Laboratory is designed to meet an important national need. The mission of the lab is mandated by law, funded by the U.S. Department of Energy, and managed by the University of California. The laboratory policy is to strengthen coordinated interaction between the lab and industry. The Los Alamos Laboratory refers to its technology transfer program as "industrial interaction." The laboratory has included in its mission statement:

"To ensure that the laboratory science and technology base is effectively used to produce significant industrial applications which enhance the security and economic posture of the nation."

One of the great controversies in the country over the last several years has been the playing off of national security issues against economic interests, with particular concern as it relates to defense oriented laboratories such as LLNL and LASL.

There has always been a great concern that the wrong type of technology will get transferred out of the laboratories and into the wrong hands. "That concern has been so strong that, I believe, it has inhibited the technology transfer process to American industry which is in a position to strengthen national security. The new policy is that the laboratory mission is to transfer technology in ways which enhance both national security and national economic interests," Mr. Longerbeam observed.

Mr. Longerbeam provided some background on the recent history of statutes and Executive Orders affecting technology transfer. "The policy framework for this new approach for federal technology transfer is represented in a series of laws and Executive Orders. The first was the Stevenson-Wydler Act of 1980, the Bahy-Dole Act, and The Technology Transfer Act of 1986. This series of legislation provides for ownership of the technology transferred by the contractor. Prior to 1980, all technology that was developed through government funding, depending upon the particular agency sponsoring the research, was owned by the government, no matter who was responsible for the research," Longerbeam told the group.

Longerbeam indicated that foreign interests, including the Soviet bloc, have capitalized on federally developed technology to a much greater extent than U.S. industry. "The U.S. was the largest technology base, therefore, we were the best target for accessing technology. This situation was tolerable while the U.S. controlled technology flow in the world, and the balance of trade was in the U.S.'s favor. It is no longer in the country's interest to do that," Mr. Longerbeam declared.

One of the principal provisions in the Federal Technology Transfer Act of 1986 provides that the federal laboratories, rather than their agencies, have the widest flexible policies for negotiating the disposition of intellectual property with private firms.

"The major thrust of the Stevenson-Wydler Act is to establish technology transfer as a mission requirement of all federal agencies (not laboratories) and required them to spend 1/2% of their research and development on technology transfer," Mr. Longerbeam reported. The combined R&D budgets of all of the federal agencies is about $50 to $60 billion a year. Applying the percentage factor, this represents about $300 million that should be spend on technology transfer a year. "It is impossible to determine if this level of funding is actually being spent on technology transfer, since there are no definitions as to what technology transfer encompasses," he observed. The Act also required all laboratories to establish an office for technology transfer.

The Bahy-Dole Act was written in 1980 and amended in 1982. This was the first Act that allowed contractors to acquire title to government funded technology. There was a strong motivation to encourage domestic commercialization of the technology, and the law was applicable to contractors and the contractor laboratories. It allowed for a simple election process for the contractor to acquire title to government owned inventions. The contractor was required to state the desire to take title to the patent. There was no permission required beyond the contractors statement of interest.

"In its first version, the Act was only applicable to nonprofit corporations and universities. Later versions of the law and Executive Orders contained provisions which encourage agencies to take the most liberal application of the Act," Longerbeam said. Laboratories, such as LLNL, were exempted from the simplified process of election, and had to ask for title rights to the inventions. The justification focussed on the national security issues in light of the defense orientation of the laboratory.

The Presidential Executive Order of 1983 encourages all agencies to apply the law as broadly as possible. However, there was little attention given to the Order.

"The most recent law was passed in 1986 and became effective January 1, 1987. It is referred to as The Federal Technology Transfer Act of 1986 or Public Law 99-502. It expanded the policy expressed in the previous laws into the cases in which laboratories were government owned and government operated. This applied to laboratories such as the NASA Ames Research Center at Mountain View," Longerbeam told the group. The laboratory directors were given the authority to directly enter into cooperative agreements with industry without prior approval of their parent agency which had been previous policy. It required that at least 15% of the royalties, up to a maximum of $100,000, collected on licensed patents be shared with laboratory employee-inventors. According to a recent magazine article, two federal inventors have already reached the maximum.

Royalty sharing with inventors in government owned, contractor operated laboratories, such as the LLNL, is a matter that is determined under the contractor's policies with their employees. The University of California has a royalty sharing policy that covers inventions and copyright material, such as computer software.

In April, 1987, President Reagan signed a new Executive Order. It directed the agencies and departments to implement the three laws enacted since 1980. "The implementation has been very slow. It appears that the statutory base is sound but there is no regulatory process which facilitates the application of the laws," observed Mr. Longerbeam.

For the first time, the Reagan 1987 Executive Order established policy to allow government contractors to retain title to such things as software, engineering drawings, and other technical data. "This enables the future licensing negotiations covering copyright material, patents, and know-how," said Longerbeam. In the latter case, there is a plethora of know-how stored in federal laboratories that is neither patentable nor copyrightable but may have great value and utility in industry. "The new policy permits these negotiations to take place at a local level. Unfortunately, we are not seeing a great surge of activity up to this time, but at least the Executive Order provides policy which is a promise for the future," Longerbeam stated.

The Executive Order established an interagency task force within the Office of Science and Technology Policy to report on the progress and problems associated with federal technology transfer. The Executive Order also included the Department of Defense laboratories within the new law.

There was a study done by the National Academy of Engineering, headed by Louis Allen, Jr., Director of the Jet Propulsion Laboratory, (NASA owned, California Institute of Technology operated), concerning the balance of "technology transfer versus technology leakage" to eastern block countries. "The study concluded that the U.S. was far too balanced in the direction protecting security, that the export laws were too cumbersome, and that the U.S. must strive for a closer balance between transferring the technology to U.S. industry where it adds to national security as opposed to putting too much emphasis on the technology protection policies," Longerbeam reported.

"The message and intent of the legislative history is very clear. The U.S. government wants tax-supported technologies to be commercialized by U.S. industry to the maximum extent possible, and that the whole process of technology transfer should be administered at the local laboratory level, not out of agency headquarters in Washington, D.C.," said Mr. Longerbeam.

There are more technologies in the federal laboratories that have commercial potential that would be supposed by looking at the labs basic mission. For example, the LLNL was established to be the nation's second nuclear weapons research laboratory. It had a corresponding mission in hydrogen fusion research from the beginning of the lab, and this has been expanded. The lab is also doing research in human genetics, gene sequencing, fusion, fossil energy research, and other broad spectrum studies. The lab is referred to as a multiprogram laboratory by the Department of Energy. "Even within the nuclear weapons research program, there is an enormous base of technologies required to support

the basic mission. Many of these have commercial potential outside of the nuclear weapons area, and the technology is unclassified. In fact, if there were an analysis of the classified versus unclassified balance, the preponderance is with unclassified technology," Mr. Longerbeam declared.

The laws have been enacted, and regulations are being developed to implement the new public policy. It is now important to examine some of the crucial mechanisms that will be required to facilitate technology transfer. Traditionally, the federal laboratories have used the public "domain approach." Included are publications, papers, meetings, symposia, and centers of information dissemination. In the latter case, examples are the National Technical Information Service (NTIS), the National Energy Software Center (copies of software), and a similar center administered by NASA. "They still work, and there is no intent to displace this mechanism," said Mr. Longerbeam. "New policy is focussed on complementing the public domain approach. Where there is a desire to achieve early return on investment and commercial potential, these mechanisms do not meet the need. The newer approaches include: licensing of patents, software, know-how, technical data, engineering drawings, and processes; cooperative research and development relationships (funded, joint funded, and unfunded); personnel exchange; contract research for industry; small company start-ups; entrepreneural spin-offs; and outside consulting (non-conflict of interest) by laboratory personnel." Longerbeam declared.

The LLNL has a research budget of about $800 million a year. Funds have also come from industrial firms interested in cooperative research. The small company start-ups that have occurred over the life of the lab have resulted in the creation of over 1,000 jobs and about $1 billion in cash flow.

An assessment was made at the LLNL to determine the level of success in the technology transfer program. The assessment was made with industrial people, and the results indicated that there were technologies in the lab that have significant potential for commercialization. The lab examined other technology transfer programs in the country to look for opportunities of emulation, and Stanford University was chosen as a model.

According to Mr. Longerbeam, the country will benefit from the new two-part approach to technology transfer. The public domain approach still has some applicability, but the new policies are crucial to near-term industry application and commercialization. He feels that the transfer process must take place in a business-like manner, and success should be measured by the amount of commercialization that takes place. The royalty process is certainly a means to quantify results.

"What are the incentives?" Longerbeam asked. "The process won't work unless there are incentives at every juncture for everyone involved." The new law and Executive Order royalty sharing provisions provide a good incentive base for inventors, scientists, and engineers. It is reasonably incentivized for the laboratories as institutions, because they can share in royalties. This won't produce a lot of money in comparison to the laboratory budgets, but it is symbolic and provides a source of discretionary funds for the laboratory directors to use appropriately. If industry is pleased with the cooperative efforts now possible, then positive statements will be made." Mr. Longerbeam is concerned that the incentives for industry are not completely clear. Nonetheless, he feels that the level of industry interest is growing. "I have personally seen a steady growth in interest since taking over the Office of Technology Transfer at LLNL. There is little indication that new policy has established incentives at agency level, yet they will be crucial in making the process work," he counseled. Longerbeam feels that there are many barriers to success that must be removed.

"We took a look at the incentive policies that have been adopted by Stanford University. They have a 1/3, 1/3, 1/3 royalty sharing program, i.e., inventor, university, and organization from which the inventor resides. Care must be taken that researchers do not get so wrapped-up in targeting for royalties that they abandon their mission research objectives. Stanford has a very business-like approach in their transfer and consider industry as the good guys," Mr. Longerbeam stated.

Small businesses are supposed to be given preferential treatment by the federal laboratories according to the new law. The experience at LLNL has indicated greater interest in technology transfer by small and medium size firms than large companies. Mr. Longerbeam hypothesizes that smaller firms are more eager to take advantage of the laboratories, since small firms do not have their own research departments and facilities.

A special factor of consideration is the philosophical challenge of providing technology transfer for commercialization without raising criticism for "making someone rich" by giving them government-owned technology paid for out of taxpayer funds. Mr. Longerbeam feels that this is a matter that should be addressed. He reviewed an experience. "LLNL was responsible for developing a new software package called Dina and Niki. It was very valuable and could handle hundreds of thousands of lines of code to apply three-dimensional finite element analysis to mechanical and structural systems subjected to stress. That was public domain software that was released a number of years ago. Neither of the two companies that capitalized on

this was domestic. One was French and the other was Japanese. It is hoped in the future this will change," he stated.

Mr. Longerbeam said that this situation typified transfer by diffusion of public domain technology. "In fact, this example is being used to oppose technology transfer. What was developed under public funds is now being sold back to U.S. users at hundreds of thousands of dollars expense. Licensing in the future will put an end to this, since licensing will be to U.S. domestic firms," he prophesized for the group.

Another factor is the retention of some inventor and laboratory rights in technology which is transferred to industry exclusively. LLNL has inserted clauses that permit lab workers to be involved in publishing activities, sharing the technology with co-workers, nonprofit organizations, universities, and through open inquiry within the scientific community. LLNL has also agreed to the delay of publication while the industry partner can secure intellectual property protection. Mr. Longerbeam feels that the transfer of any technology does not occur with just the license, but feels that the partnership concept is crucial.

Mr. Longerbeam expressed optimism that the new system of laws creates a positive environment for the transfer of federally owned technology to the private sector for commercialization but cautioned that much must be done to accomplish the broad objectives of the new policy.

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KEYNOTE PRESENTATIONS

JOSEPH W. MARTINELLI

"The subject of this Forum is probably one of the most exciting and yet perplexing challenges that we in California and the nation face," said Joseph Martinelli, General Manager, Engineering Department, Chevron Corporation. "Exciting because we are talking about a virtually untapped national resource, federally owned technology; and perplexing because many of the past attempts to transfer federally owned technology to the private sector have failed miserably," he continued. "My hunch is that we are standing on the edge of a dynamic opportunity, and I am pleased to be a part of the California Engineering Foundation and its creative initiative to assure that the broad objectives of the new Act are achieved."

The implementation of the new Federal Technology Transfer Act will require a clear understanding of needs, motivations, legal requirements, and a plethora of other considerations. Mr. Martinelli provided an overview of the challenges that lay ahead.

One of the objectives of the new law is to create a partnership between industry and the federal laboratories. In order to do this, each member of the partnership should know what they are seeking from the arrangement. "If anyone thinks that there are a large number of "widgets" sitting on the shelf of federal laboratories waiting to be innovated and commercialized in the private sector, they will be disappointed," Martinelli advised. Defining the needs of industry in light of the capabilities of the labs is an important requirement according to Martinelli.

"The practical limits of people, money, and materials must be understood by both industry and the laboratories. Shared personnel is one option in the spectrum of technology transfer activities. However, industry probably cannot afford to have large numbers of its staff on location at federal laboratories," said Martinelli. "Correspondingly, the laboratories have assigned missions to accomplish, and although technology transfer is a requirement for all laboratories, staff time will be allocated with priority given to mission tasks," he advised.

Mr. Martinelli also discussed the desirability of industrial access to federal laboratory facilities but noted the conflict that can occur between the goals-oriented industry and the mission-oriented laboratory. "Wind tunnels, powerful computers, unique test setups, rocket test stands, or other specialized research equipment represent a tremendous asset for both the federal and private sectors. There must be many opportunities for sharing these facilities if means can be found to do so without interfering with the main function of such equipment," he said.

Other areas of concern include legal, policy, and security constraints. "How does a laboratory transfer what should be unclassified technology from a classified project? How can intellectual property rights be secured in a policy environment that has accomplished technology transfer in the past by public release of information?" Martinelli questioned. Additional issues include industrial proprietary information, licensing, preferential access, exclusivity, anti-trust laws, liability, interpretation of the law as it relates to funding requirements for FLC activities, contracting, and many other issues embodied in rules, regulations, policy, and laws.

"Effective technology transfer requires both a "push" and a "pull," Martinelli declared. "The possessor of the technology must be motivated to push it out of the laboratory, and the user must want to pull it into his organization. What incentives do federal laboratories have to stimulate the transfer of their technology? What will stimulate industry to seek assistance from the laboratories? Motivation of all parties is our biggest challenge," Martinelli declared.

"In summary, I believe there are two principal sets of obstacles to the effective transfer of federally owned technology into the private sector: one category deals with institutional or procedural challenges; and the other concerns challenges that arise from attitudes and behavioral patterns of the people involved," Martinelli feels. "The former is real but lends itself to precise resolution when concerned and committed individuals take the initiative to change laws, regulations, policies, and procedures. The latter is much more formidable, since attitudes and feelings are intangible and sometimes illogical," observed Martinelli.

In developing a strategy for technology transfer, Martinelli feels that it should not be necessary to tailor hundreds of unique systems to apply to the many individual laboratories, agencies, departments, or companies. Consistency and commonalty is a major challenge. Those who have been actively involved

in technology transfer are well aware that it is a people-to-people activity more than anything else. "Matching people in industry with their counterparts in the laboratories is a key objective. Our challenge is to recommend ways to build these relationships."

Traditionally, federal policies have given low priority to technology transfer. The federal agencies mission objectives are sacrosanct and are not necessarily conducive to sharing technological discoveries or participating in joint research programs. Similarly, some of the policies of corporate America resist effective technology transfer, especially, from "outside" sources. Industry has become accustomed to a "go it alone" philosophy. Anti-trust laws have ground into the psyche of American companies that competition is to be preserved. "Now in order to become more "competitive" in the world market, cooperative efforts between domestic competitors may be crucial to international survival. How can we overcome this corporate culture?" Martinelli queried.

One of the major constraints to industry/laboratory cooperation is institutional inertia. Industry has the perception that bureaucracy runs on a slow clock, while industry runs on a faster one. "Means must be developed to streamline and simplify the approval process which allows technology to be transferred. Perhaps the new law, which attempts to give laboratories the capability to execute agreements with private firms without going through their agencies, will facilitate the process. We should explore what industry can do to help the labs secure the authority they need," Martinelli advised.

The innovation of technology in the competitive environment of the private sector requires some assurance of protection of the investment. This means that exclusivity is crucial to providing incentives for commitment of financial and other resources by industry. "The early release of information of new technology, whether inadvertent or intentional, may destroy patent rights," said Martinelli. "This is a serious concern to industry. Where there are joint ventures between a laboratory and company, the disposition of any intellectual property should be a matter of early resolution. Where contractual negotiations are required, they should be timely. Delays of even six months can be unacceptable in light of critical schedules in industry," Martinelli declared. "How can we accelerate the negotiating process?" he asked.

Mr. Martinelli shared a personal experience in which Chevron was interested in having access to federal technology associated with alternative fuels. "Chevron attempted to visit a pilot plant on synthetic fuels technology. This project was federally funded and jointly operated with another oil company," he related. "At the time, Chevron was privately funding an alternative process, — also a pilot project. Even though scientists from both projects were willing and anxious to compare notes on a noncompetitive basis, the federal adminstration obstructed our entry for months before access was finally arranged. This obstruction occurred at the same time that plant visits were being actively encouraged and conducted for local business and educational groups, and our nation was even encouraging Russian scientists to visit similar facilities," Martinelli lamented.

A cooperative environment must be created. Laboratories should make known to industry the type of research that is taking place and the technology that is being developed. Correspondingly, industry must be willing to share some of its secrets. Both parties must recognize the need to establish and maintain active contact. "Chevron has not been aggressive in this area in the past, but I can share with you one successful experience here in California. The Lawrence Berkeley Laboratory and the Chevron Research Laboratory at Richmond are in close proximity. Some of the Chevron scientists had a need to use the sophisticated electron microscope at the LBL, and some of the LBL scientists were very interested in discussing catalyst technology developed by Chevron. After a series of informative seminars and lectures, we managed to establish some very constructive contacts — and technology exchange was accomplished," Martinelli stated.

Trust and cooperation are key elements in addressing the strategic challenge of technology transfer. "Within industry, there is a perception that the federal labs don't really want technology transfer to occur. I've heard comments that "they're just going through the motions" or "there is a lack of commitment." On the other side, there is the perception that corporate America is often indifferent to technology transfer. The labs say, "industry must tell us what they want before we can help them," Martinelli said. "Cooperation is the key to success. Industry must overcome its pride and "the not invented here syndrome" and the laboratories must realize that greater use of the nation's developed technology is a crucial mission objective and is a matter of clear policy. We are not going to solve all the problems immediately, but we can produce something to build on, and that's good enough. Progress, like a long journey, begins with the first few steps."

CASE HISTORIES

The transfer of technology from a generator to a user is a complex process, and there is no single panacea. In the past, principal means for transferring federal technology to the private sector was through "diffusion." Government-owned technology was considered to be in the public domain. Researchers in the federal laboratories published their findings or made presentations at technical conferences and symposia. Other researchers would conduct literature searches or be exposed to new technology at meetings. Subsequent contact in areas of interest caused the transfer to occur.

Some firms have a policy of regular contact with federal laboratories involved in research relative to the company's product line or field of technology. The person-to-person contact is extremely valuable. This technique is an excellent example of the phrase, "technology transfer is a body contact sport."

Another technique is the transfer of the technology through the mobility of the technologist. An example is the researcher in a federal laboratory who is inclined to become an innovator and entrepreneur. The ability of a researcher fulfilling these ambitions is closely coupled to the level of support provided by the laboratory, and most of the action taken in this area would have to be highly individualistic. In many cases, the upper level decisions made to support the candidate entrepreneur are off the record and in some cases in direct opposition to established policy.

Insight into the process can be gained by examining case histories of successful transfers that resulted in new products and enterprises. The Forum contained a panel of six individuals who were involved in successful transfers, and highlights from these stories are contained in this section.

CHAIRMAN:

Dr. Richard C. Wayne, Director, Component Systems Research, Sandia National Laboratories, Livermore, California

PANELISTS:

Abraham Furman, Senior Research Scientist, Pacific Hemostasis, Ventura, California

Dr. Donald Holve, President, Insitec, San Ramon, California

Carolyn McClain, Product Manager, Scientific Computing Systems, San Diego, California

Eugene Potkay, Member, Technical Staff, AT&T Bell Laboratories, Murray Hill, New Jersey

Richard Werthamer, Executive Director, Becton-Dickinson, Franklin Lakes, New York

David Herting, V.P. Engineering and Chief Engineer, The MacNeal-Schwendler Corp., Los Angeles, California

CASE HISTORIES

PACIFIC HEMOSTASIS — ABRAHAM FURMAN

Abstract

A transfer of hybridoma biotechnology from a federal laboratory (Lawrence Livermore National Laboratory) to Pacific Hemostasis occurred over an 18 month period. The initial contact resulted from a literature search. Prior to spotting the technology in open reports (diffusion technique), the firm had no knowledge that the Lawrence Livermore National Laboratory was involved in research associated with monoclonal antibodies.

During the first year, there was close interaction between researchers at the laboratory and the company. Technical interchanges during the first year included contacts with the respective patent offices, and final legal transfer occurred during the last 8 - 10 months. An extremely good research level communication base enabled Pacific Hemostasis to complete scientific evaluation, research, and product development at a fast rate. The success of this particular transfer was due largely to the close working relationship between an aggressive small company and a federal laboratory headed by researchers who were positively motivated to transfer technology.

Description of the Technology

State of the art hybridoma technology at Lawrence Livermore National Laboratory provided a strong working standard for the production, propagation and characterization of monoclonal antibodies with finely tuned characteristics such as avidity, specificity, stability, and sensitivity.

A monoclonal antibody produced by LLNL described in scientific journals was of particular interest to Pacific Hemostasis, because it matched the firm's research and development department's on-going research. The Senior Research Scientist made initial contact with the head of the laboratory at LLNL. A one-on-one exchange of ideas and goals was the primary link between the two labs.

Description of the Federal Laboratory

The LLNL from which technology was transferred was not in a classified work category. This made it extremely easy for a small company such as Pacific Hemostasis to interact with the Laboratory. The Laboratory was eager to expedite its research expertise and products to the private sector. The University of California administers LLNL under a contract arrangement with the U.S. Department of Energy, consequently patent and other legal matters fall under the jurisdictional control of the University. Relationships between Pacific Hemostasis and the U.C. offices at Berkeley were positive and constructive and expedited the legal transfer of the technology. Cooperative communication exists between LLNL and the administrative offices of the University.

Description of Pacific Hemostasis

Pacific Hemostasis is a small medical manufacturer of clinical laboratory hematology diognostic reagents. Up until the acquisition of hybridoma technology from LLNL, all of Pacific Hemostasis products relied on standard nonbiotechnically derived antibody components. Because of the limitations of these standard reagents, the firm's research and development efforts were limited in new product scope. The acquisition of this particular monoclonal reagent has enabled the firm to produce a new, unique product for the clinical lab market. The firm is now developing new reagents, based upon monoclonal antibody technology, that are highly specific in the screening of blood to search for the presence of target diseases.

Motivating Factors

The general state of medical diagnostic technology is now on the threshold of a new era with diagnostic possibilities unthinkable just a few years past. However, the new technologies come at a very high price in terms of time, personnel, and money. A small company, such as Pacific Hemostasis, has little chance to acquire new technologies on its own. However, the beauty of a small company is that product turnover and development is usually faster than that of a larger company once the technology is acquired. Therefore, the availability of federal laboratory technology is ideal for a small company such as Pacific Hemostasis.

Pacific Hemostasis has nonexclusive rights to the hybridoma cell line. A standard initial fee and royalty base contract was signed by Pacific Hemostasis. The contract negotiations and finalization of federal transfer was handled by the Vice President/General Manager of Pacific Hemostasis. Up until that time, most ongoing communication occurred between researchers at both facilities. This two-step arrangement worked well for the firm.

Major Constraints or Impedances

The only impedance to the transfer of technology was that specific guidelines for the transfer process had to be learned, i.e., there was no standardization of procedures. Therefore, the transfer process was slowed by the education process. The Patent Offices assisted in resolving the difficulties to the satisfaction of both parties.

Techniques Used to Resolve Impedances

Personal communication between researchers in the federal laboratory and the firm was the most effective means of resolving conflicts. Most of the interaction took place by telephone.

Recommendations for Change

Specific guidelines and regulations covering technology transfer should be understood not only by the heads of all federal laboratories, but also by individual researchers. This would facilitate technology transfer in several ways: (1) the laboratories would know how to handle the process; (2) understanding all the regulations puts the laboratory on a positive framework and state of mind from the beginning; and the initial communication between the federal laboratory and the outside company can be immediately set in the right framework so that both parties will do all the right things to properly expedite the transfer of the technology.

CASE HISTORIES

INSITEC — DONALD HOLVE

Abstract

Lasers have been used for many applications since their discovery. What once was a laboratory curiosity is now a devise that meets many needs in society including unique manufacturing techniques, medical applications, telecommunications, and space defense. Another application of this technology is in the instrumentation field. Work related to combustion of pulverized coal at the Sandia National Laboratories in Livermore, California, resulted in the development of a laser device to monitor particle size. The researcher involved in this work became an entrepreneur and developed the technology for commercial use. Through highly creative management at the Laboratory, assistance was provided to the researcher to make the transition from researcher/inventor to innovator/entrepreneur.

Description of the Technology

The technology uses the laser phenomenon, together with unique computer integration and software development, to measure particle size of an on-going process. Originally, the technology was developed in conjunction with research on combustion of pulverized coal. There is a correlation between particle size, combustion dynamics, and combustion efficiency. The spin-off technology transferred was in the form of instrumentation and software.

Description of the Federal Laboratory

The Sandia National Laboratory has a broad mission in research for the U.S. Department of Energy. The Laboratory is operated by AT&T under contract from DoE and is referred to as a "government-owned, contractor-operated" laboratory. The policies under which the Laboratory function are those imposed by DoE as part of the contractual arrangement with AT&T and those of AT&T itself. One of the Laboratory specialties is in the field of combustion dynamics.

Motivating Factors

The researcher at Sandia, a graduate mechanical engineer from the University of California, Berkeley, was pleased with his research position as an employee of Sandia (AT&T). His desire to see his research project further developed was a prime motivating factor in his quest to become an entrepreneur. He also had a desire to create and run his own business. Laboratory supervision was sympathetic to the commercialization of the technology and provided administrative and philosophical support to the inventor. The inventor was also allowed to do external consulting while still a member of the Laboratory staff. This produced excellent industrial contacts, insight into market viability of the product and source of income independent of his Laboratory salary. With the help of the Laboratory, the inventor did not have to seek venture capital funding.

Major Constraints or Impedances

Rules and regulations in the Laboratory, if strictly implemented by the management, would have impeded the transfer of the technology. At the time of the transfer, policies were not conducive to the type of support the project and the inventor received from the Laboratory. Staff personnel were not allowed to do outside consulting — a key element in determining the "market need" for the technology and establishing the crucial contacts needed to influence design and develop potential sales. Had the same situation existed in a government owned, government operated laboratory, the transfer would probably not have been possible. Under the new Federal Technology Transfer Act, policies are changing.

Techniques Used to Resolve Impedances

Credit goes to the management of the Sandia National Laboratories who were willing to liberally apply the normal operating procedures to facilitate the transfer process. Assistance was given to external consulting and the preparation of proposals for a SBIR (Small Business Innovative Research) grant. The proposal was successful, and the initial $50.000 grant was instrumental in demonstrating proof of concept. This support led to a follow-on grant of $500,000. With the philosophical support of the Laboratory management, the opportunity to establish external contacts in the field of

technology, and the financial assistance from the SBIR program, there was no need to seek venture capital nor go heavily into personal debt to establish the enterprise.

Recommendations for Change

Federal laboratory policies need to be modified to assure strong upper-level support to individuals having the opportunity to become entrepreneurs. Presently, there is no uniformity in such policies. Sandia, being a private firm under contract, has greater flexibility in policy-making which permits support for the entrepreneurial efforts of a laboratory researcher.

One of the most important means of facilitating technology transfer is to permit the laboratory researcher to do external consulting in his or her field of technology. This consulting should be on a fee basis. The people-to-people contact is one of the most effective mechanisms for transfer. The contact with industry researchers assists in modifying negative attitudes about the work taking place in the laboratories. In addition, laboratories are usually not motivated by some of the major concerns in industry, such as schedules and cost, and the consulting activity benefits both parties in learning of the differences. Industry becomes aware of the technology, and the laboratories discover new and more efficient means for conducting highly productive research at reduced cost.

CASE HISTORIES

SCIENTIFIC COMPUTING SYSTEMS — CAROLYN McCLAIN

Abstract

A cooperative arrangement was established between the Lawrence Livermore National Laboratory and Scientific Computing Systems Company in which SCS provided staff assistance to the LLNL to develop a compiler for the SCS super computer. The complier was based upon technology that had originally been developed by LLNL for a Cray super computer. The objective was to use this technology to develop a compiler that can translate "Language C" to native computer language. A nonexclusive licensing agreement was executed between SCS and the University of California which provided for royalty payments to be made to the University on all profit sales. The agreement exempts any royalties on nonprofit sales such as those to educational institutions.

Description of the Technology

The technology that was transferred was a computer software compiler that takes a program written in "Language C" and converts it into binary computer code. The compiler was developed to increase the use of a super computer manufactured by the company and thus extend the versatility of the computer. Originally, the software technology was developed for use with a Cray super computer. Scientific Computing Systems sold one of its super computers to the Lawrence Livermore National Laboratory which instigated the development of the compiler.

Description of the Federal Laboratory

The Lawrence Livermore National Laboratory is operated by the University of California under contract from the U.S. Department of Energy. A large portion of the Laboratory's mission is associated with classified research in strategic weapons and nuclear energy. The technology transferred was unclassified.

Description of Scientific Computing Systems

The company manufactures a super computer system that fills the void between regular systems and the very large and complex system called Cray. Super computers have extremely high processing rates. The SCS machine has about 1/4th the speed of a Cray and is marketed at about 1/5th the price. The new compiler was a major improvement in the firm's product line, since it extended the use of equipment for the company's clients.

Motivating Factors

The strongest motivation for transfer of the technology was to extend the capability of the company's product. SCS provided loaned staff to assist in the development of the compiler. LLNL benefitted by having extra staff personnel available at no cost to the laboratory.

Major Constraints or Impedances

SCS made its original contact with the LLNL as a client. LLNL purchased a SCS super computer for use by the laboratory. In discussions associated with the sale, SCS became aware of the fact that LLNL had developed a compiler to be used with the Cray super computer. As a result of these discussions, the development of the compiler for the SCS machine began. The cooperation was ideal and no constraints were experienced.

Under the contract that the University of California manages the LLNL for the Department of Energy, intellectual property rights revert to the University. Consequently, negotiations were needed between SCS and the University Patent Office to secure a nonexclusive license for use of the compiler technology. The license provides for royalty payments to the University of California as a percentage of profit sales. Sales to nonprofit organizations are exempt from the royalty payments.

Techniques Used to Resolve Impedances

The approach that was used to transfer the technology obviated any impedances. Excellent relationships had been established, and SCS's willingness to provide their staff to LLNL during the research and development period was synergistically beneficial to both the lab and the company. Another potential constraint was the development of the licensing arrangement between SCS and the University. However, negotiations were cordial and timely, and both parties were motivated to establish an equitable arrangement.

Recommendations for Change

SCS feels that the transfer process was ideal and should be replicated in the future if the opportunity is present.

AT&T BELL LABS — EUGENE POTKAY

Abstract

The technology relates to the manufacture of fiberoptics for use in telecommunications. The transfer of the technology from the Sandia National Laboratories was initiated by AT&T. The means for transferring the technology was through the assignment of an AT&T researcher for a period of time to the Sandia Laboratory at Livermore, California. Sandia contains one of the most sophisticated combustion research laboratories in the nation, and AT&T is interested in technology associated with combustion as it relates to the manufacture of the fiberoptical material used in telecommunications.

Description of the Technology

Fiberoptics is considered a breakthrough in the field of telecommunications. The transmission of voice or data over long distances through copper wire has its drawbacks. Copper lines have limited capability in terms of numbers of simultaneous transmissions that can be carried. Also, they can be subject to spurious errors that can occur with any electrical conductor. Light transmissions over photo-optical cables can carry significantly more simultaneous transmissions and are not subject to spurious interference.

Critical in the development of fiberoptic transmission lines is the efficiency with which the "conductors" carry light signals and the cost of manufacturing the fiberoptic material. The technology involved in this transfer related to both.

The manufacture of an optical fiber begins with the process of "growing" a rod of glass that has the proper material matrix cross-section needed to efficiently carry the light wave. The technique used is flame deposition. Thus, the size of the particles and their chemical makeup are critical elements in making the rod or mandrel from which the fiber is drawn. The final fiber has the same matrix cross section as the mandrel at a fraction of the diameter.

Sandia Laboratories Combustion Research Laboratory had developed technology that related to measuring very small particles in combustion streams. The objective of the technology transfer was to use this technology in the manufacture of the composite glass rod (mandrel) at the AT&T Bell Laboratories. Areas of greatest concern were: combustion diagnostic techniques, glass "soot" (small particle) deposition, vapor phase torches, probing of vapor phase burners for fiberoptic production, laser techniques for temperature determination, light scattering measurement techniques, and real time measurement of submicron particle size.

Description of the Federal Laboratory

The Sandia National Laboratories were established in 1949 as a wholly owned subsidiary of AT&T through its former Western Electric manufacturing entity. As a nonprofit Delaware corporation under a no-profit, no-fee contract with the U.S. Department of Energy (DoE), Sandia's major responsibilities are the conduct of national security and energy projects. In 1956, Sandia operations began at Livermore, California where the Combustion Research Facility (CRF) was established in 1980. The CRF is supported by DoE's Office of Basic Energy Sciences and is dedicated to the acquisition and exchange of knowledge that will ultimately improve the nation's ability to control the combustion process. An important element of the CRF charter is promoting the development and application of new combustion research tools, based primarily upon laser diagnostics. The CRF serves as a focal point for DoE-sponsored combustion research and actively involves the combustion research community at large through its Visiting Scientist Program.

Description of A&T Bell Laboratories

AT&T remains the foremost telecommunications company in the United States following divestiture by decree from the U.S. Justice Department under Judge Greene. Since divestiture, AT&T has undertaken an unprecedented transformation from a regulated telephone utility with a captured market to the competitive, market-driven telecommunications company it is today. In the turmoil of massive reorganization of its lines of business, AT&T's policy on technology transfer continues to be reexamined. Internally, expeditious technology transfer from research and development to manufacturing is deemed critical to AT&T's survival as a U.S. manufacturer.

AT&T had several labs investigating various aspects of silica combustion synthesis including the AT&T Engineering Research Center (ERC) of Princeton, New Jersey, AT&T Bell Laboratories at Atlanta, Georgia (BA-AK), and AT&T Bell Laboratories at Murray Hill, New Jersey (BL-MH). The BL-MH program addresses vapor-phase process studies from the most basic standpoint relative to the ongoing development efforts at ERC and BL-AK. The capabilities of that facility include Schlieren flow-field visualization, qualitative light scattering, infrared emissions spectrometry, and online, real-time deposition rate monitoring, and a recent development from which particle velocities may be obtained. Compared to the charters of the ERC and BL-AK programs, it can be concluded that the nature of the work conducted by the Murray Hill group is basic and fundamental. Relative to the interest of the combustion research community, at the Sandia CRF, the Murray Hill work is applications directed.

Motivating Factors

AT&T was highly motivated to obtain new technology from the federal laboratory under AT&T management — the Sandia National Laboratories. Research funded by DoE could be an excellent free source of data and technology. Prior to divestiture, AT&T kept an "arms length" relationship with Sandia. After divestiture, the potential for closer working relationships between AT&T and its Sandia subsidiary had materialized. Marketplace competition requires increasing the effectiveness of research, and tapping Sandia was good strategy.

In addition, AT&T was not in a position to enter broad basic research in the field of optical fiber (light guide) production. Sandia was involved in highly basic research, and the technology was potentially useful to AT&T. The combustion diagnostic resources available at Sandia's Combustion Research Facility are significantly advanced over AT&T's capability. AT&T felt that Sandia's expertise in combustion and fields related to light guide manufacturing could be beneficial to the company's needs in these areas.

Major Constraints or Impedances

The program experienced many of the classical constraints in technology transfer. "Not invented here" syndrome, intracompany turf questions, near-term orientation in a strategic environment, inability to predict quantifiable payoff for the investment in the company/laboratory interaction, tangential impacts on personnel career momentum and goals, and out-of-sight, out-of-mind risks to professional staff were factors of consideration from the company side. Thus, the individuals interested in tapping external sources of technology have an uphill battle to justify the search, find, and transfer process. The payoff for the transfer may not always be tangible and immediate. The result may be manifest over a long period of time.

Techniques Used to Resolve Impedances

In several aspects of the collaboration that took place between AT&T and Sandia, normal procedures were circumvented in both organizations. Consequently, certain risks were assumed by the participants directly involved in the transfer process. The risk taking can, if successful, be highly beneficial to careers, but the downside if expectations are not realized can be disastrous. In this particular case, the risk/benefit ratio was even more hazardous, since there were no guaranteed rewards for success.

One of the major factors of consideration was the resolution of the near-term vs long-term objectives of the two organizations. The company needed results which can only come from applied research, and the laboratory had a basic fundamental long-term motivation. In order to satisfy the short-term need, the collaborative efforts focused on applied research on actual manufacturing equipment for "light guide" (optical fiber) production. This approach was not the most suitable for basic studies within the mission of Sandia Laboratories technical staff. Sandia appointed a newly hired project person willing to engage in applied research efforts. AT&T appointed a key member of its staff as their contribution to the collaboration.

The approach was not optimum in light of the four-month assignment proposed, since neither of the researchers were familiar with the facilities at the laboratory. The initial funding for the collaboration was mutually supported by internal research and development funds at Sandia while the salary and expenses of the AT&T researcher were covered by AT&T. It was the long-range intent of the project to establish a budget within AT&T to cover the cost of the collaborative efforts thus permitting AT&T to obtain exclusivity in any developed intellectual property. Lacking this funding would require that support provided by Sandia and funded by the DoE would result in making the technology open to the public. This question was not resolved, and the work being accomplished was restricted to nonproprietary investigations.

There was sufficient promise for success that the collaboration is being continued. Presently, the research work is targeted on diagnostic capabilities for measuring flame temperature in a "sooting silica" flame (deposition process for making the glass mandrel) based on obtaining the maximum light transmission efficiency of the optical fiber.

BECTON-DICKINSON — RICHARD WERTHAMER

Abstract

The technology transferred from the Lawrence Livermore National Laboratory related to medical instrumentation. A cooperative research effort was initiated and proved successful. Difficulties were experienced in the legal transfer of the technology because of delays imposed by the DoE. Policy issues resolved in the renegotiation of the University of California LLNL management contract with the Department of Energy permitted the University to make the final determination of before-the-fact disposition of intellectual property rights. All other actions related to the transfer of the technology were satisfactory and in a timely manner.

Description of the Technology

The technology is associated with medical instrumentation.

Description of the Federal Laboratory

The technology transfer arrangement was made between Becton-Dickinson, Lawrence Livermore National Laboratory and the University of California at San Francisco. UCSF specializes in medical education and research. LLNL is operated by the University of California under contract from the U.S. Department of Energy. Its mission is primarily associated with research related to strategic weapons and nuclear energy.

Description of Becton-Dickinson

Becton-Dickinson is a billion dollar gross sales company in the Fortune 400 listing. It specializes in medical products, including medical diagnostic instruments.

Motivating Factors

The company contacted the laboratory because of the work that was going on in the field of biotechnology. Also, LLNL was a purchaser and user of some of the research equipment that B-D manufactures and sells. Staff at the firm was familiar with their counterparts at the laboratory. The company's interest was to conduct joint research for the development of new diagnostic systems in the medical field.

Major Constraints or Impedances

Negotiations with the laboratory were smooth and cooperative with great enthusiasm on the part of the University and the LLNL management. Draft agreements were executed in a reasonable period of time and encompassed not only the working relationship but also the disposition of any intellectual property rights.

Difficulties were experienced over the months with the DoE, the owner of the LLNL that U.C. manages. The principal problem with DoE was with the disposition, in advance, of intellectual property rights. The delays occurred in spite of the presence of laws that provide for laboratories to transfer intellectual property to private sector businesses. DoE was very slow in transferring the rights, and B-D could not initiate its funding of an expensive research program that would last several years without assurance in advance that the company would have exclusive rights to the inventions that would emerge from the program.

Techniques Used to Resolve Impedances

The University of California had to petition DoE to grant advanced waivers to any intellectual property that would evolve from the joint research efforts. The DoE neither said no nor yes to the petition, but succeeded in avoiding any violation of laws or Executive Orders by just doing nothing. The U.C. was diligent in following up with DoE to secure a resolution to the problem.

The break in the case came in the summer of 1987 when U.C. negotiated a renewal of its contract to manage the three DoE laboratories. Under the previous operating contract, the DoE retained title to all inventions resulting from the research work in the laboratories, and the U.C. could petition to have the DoE waive its rights, which is what DoE was not doing. In the renegotiated contract, U.C. was given title to the inventions in nonweapons areas. DoE still retains rights in the weapons related work. More than half of the work at LLNL is nonweapons related. Thus, U.C. has the power to execute agreements with private sector businesses such as B-D.

The agreements are to be completed between B-D and U.C. effective October 1, 1987, and joint research will begin. DoE is no longer a party to the agreements. B-D will have appropriate options to exclusive rights to inventions.

CASE HISTORIES

MacNEAL-SCHWENDLER CORPORATION — DAVID HERTING

Abstract

The transfer of technology from a federal laboratory to private sector industry is complex. Some of the technology cannot be easily moved on paper or magnetic tape. MacNeal-Schwendler, having established a relationship with NASA laboratories, assisted in the development of a software package that had high utility in structural, dynamic, and thermal analyses. Private industry's interest in the computer analysis demonstrated a need for assistance in transferring the technology, and this was the basis for the MacNeal-Schwendler business. The company has now created over 800 clients and offers analytical software programs across the board.

Description of the Technology

The technology that has been transferred is computer software. Originally, MacNeal-Schwendler Corp. assisted NASA in a consortium to develop an analytical program. The close working relationships between NASA and the firm made it possible to expand the number of analytical programs transferred from NASA to the private sector.

Description of MacNeal-Schwendler Corporation

The company is an engineering firm dealing in computer software. The company has experienced growth from its original size of ten people in 1963. The principal product is a structural analysis program dealing with mechanical aspects of a structure's stress and dynamics, including thermal effects. The analysis is applicable across a wide spectrum of components from microchips to space stations.

When NASA formed the consortium, MacNeal-Schwendler was on the development team. Computer Sciences Corporation was the prime contractor. The company began its work with NASA funding. The NASA centers formed a consortium and raised $2 million to do the initial development of this computer program. At that time, this level of funding for a computer program was considered unusual; but looking back, it displayed a tremendous amount of foresight.

A private industrial firm became aware of the existence of the program and requested a copy. The complexity of the program resulted in NASA delivering a large volume of tapes and documents with little or no instructions of how to install the program. MacNeal-Schwendler was hired by the industrial firm for its assistance in accomplishing the transfer process. The company has grown from its original role of assistance to others to production and lease of its own software.

The company has penetrated a wide range of industries with analytical programs from analyzing manufacturing processes to space operations. The area that had not been penetrated was civil engineering.

The firm now has over 800 contracts with clients in areas well beyond the original scope. The full field of analysis is covered, and investment is being made in the research and development of new programs.

Motivating Factors

The original motivating factor was to assist other private sector firms in interpreting and using NASA-developed analytical software programs. The firm now has evolved to the point where it develops its own programs in a wide spectrum of engineering.

Major Constraints or Impedances

The original impedance to the technology transfer was between NASA and the requesting industrial firm wanting to make use of the NASA computer program. MacNeal-Schwendler capitalized on the difficulties in the transfer process and became a facilitator between the technology generator and a potential user.

Techniques Used to Resolve Impedances

The company has a good working relationship with NASA.

FEDERAL TECHNOLOGY TRANSFER FORUM

WORKSHOPS

Introduction

The purpose of the workshops was to explore some of the cogent issues related to the transfer of federally owned technology to the private sector. The four workshops examined different aspects of the challenge to determine where human and where institutional impedances exist. CEF workshops use the techniques of process design to facilitate discussions that are targeted on the production of precise recommendations — critical success factors.

The workshops were chaired by individuals having a sensitivity to a particular aspect of the technology transfer challenge. Panelists were selected to provide a brief perspective of specific areas of concern. This summary report, presented in brief outline form, represents the essence of the pre-forum research and forum workshop products in an integrated format. The findings are not to be considered all inclusive but illuminate the complexity and diversity of challenges facing the effective implementation of any national policy to transfer federally owned technology to the private sector. Technology transfer is a "body contact sport." A general mission statement could be, "to facilitate technology flow through the definition of focused needs and development of communications channels." Therefore, one of the major challenges is to identify new and more efficient mechanisms to stimulate people-to-people interaction.

Workshop Products

Vision Statement. The vision statement is a description of the "ideal state" at some time in the future when all of the issues in the workshop subject area have been resolved. The statement is written in the present tense as though one were describing the situation in the most optimistic perspective — as though all constraints had been resolved and the process meets all objectives.

Constraints, Impedances, and Issues of Consideration. These all relate to matters of concern that must be addressed and appropriately resolved. A constraint is a difficulty that lends itself to resolution. An impedance is a block to success that must be circumvented or neutralized (such as an institutional policy that must be changed). Issues are factors of consideration that may or may not be constraints or impedances but require evaluation.

Critical Success Factors. The concise recommendations that address the constraints, impedances, and issues are called, "critical success factors." They are the resolvers that overcome obstacles thus permitting the achievement of the "ideal state" as described in the "vision statement." One critical success factor may address several constraints (et al). If the goal can be achieved without taking a specific action, it is not a "critical success factor." All of the above are strategic planning elements. Action can be initiated on many of the critical success factors. Others are general in form and require further definition to produce tactical actions.

Workshop Findings

The Workshop findings are presented in the following four sections. A summary of the types of actions that should be taken by the California Engineering Foundation to facilitate the implementation of the critical success factors is presented as a part of each Workshop report. Included in these recommendations are both suggestions made by the workshops themselves and additional actions that CEF feels are appropriate within its charter and past experience.

Many of the critical success factors are strategic and focus responsibility on "industry and government" but do not define the responsible entity who should take charge. Implementation of any strategic plan necessitates the development of tactical plans which specify who can and should be taking the initiative. The ability of the CEF to assume a leadership role for further development and execution of tactical plans will be determined by the level of support that CEF receives from industry, federal laboratories, state government, agencies, and other granting organizations.

WORKSHOP 1 — INDUSTRY NEEDS AND LABORATORY CAPABILITIES

CHAIRMAN:

Donald I. Carter, Director, Aerospace and Electronics Technology, Rockwell International

PANELISTS:

Dr. Richard LaBotz, Aerojet TechSystems Company

Mr. Gordon Longerbeam, Lawrence Livermore National Laboratory

Mr. Thomas Miles, Argo Systems, Inc.

Dr. Robert Storer, Naval Civil Engineering Laboratory

Ms. Cathleen Connell, NASA Ames Research Center

This workshop addressed the technical disciplines, knowledge, and facilities currently available in federal laboratories and the mechanisms available for industry to capitalize on these capabilities. It also addressed industry needs for technology. Ultimately, the industry needs should be expressed from a strategic perspective and include not only the technology but the factors that can affect the usability of the technology such as format, codification, frequency of availability, timeliness, accessibility, and other considerations that fit the laboratory programs and the industrial requirements. Laboratories' capability can include potential development of documentation describing these capabilities, mechanisms for technology transfer, and the breadth of research activity in the laboratories.

Vision Statement

A close empathetic partnership exists between federal laboratories and industry. Industry has identified its needs in terms of generic types of technology that has high usability and the form in which the technology should be transferred. Industry carefully monitors research activities in the federal laboratories and has developed procedures which permit rapid technology assimilation and transfer. Federal laboratories are sensitive to the needs of industry and familiar with the types of technology that are most likely to be transferred to characteristic industries. Reports, data, documentation, computer files, and other means for storing, searching, and retrieving the technology are designed with a "user" in mind. The U.S. national competitiveness position is enhanced by facilitating the flow of technology through defining focused needs and communication channels.

Constraints, Impedances, and Issues of Consideration

1. Knowledge of available technology
2. Technology transfer mechanisms
   - contracts
   - grants
   - joint projects
   - consortia
   - people/information exchange
   - licensing
3. Knowledge of test facilities and equipment
4. Ease of accessing technology including format, standardization, and communication
5. Characterization of industry needs
   - data
   - design and manufacturing processes
   - testing and test results evaluation
   - techniques
   - instrumentation
   - software programs
   - analytical approaches, including mathematical modeling
   - materials, components, and subsystems
   - man/machine interface procedures, systems, and controls
   - quality assurance techniques, including nondestructive inspection
   - measurements and measurement techniques
6. Creating an environment to use and leverage the technology
7. Communicating and facilitating techniques

Critical Success Factors

Federal Laboratories should:

- Enhance the entrance (market) of industrial firms in related fields of technology.
- Develop brochures that describe:
  - — mission objectives
  - — facilities, equipment, and instrumentation
  - — generic technologies that are available
  - — mechanisms for industry involvement
  - — licensing of patents
  - — points of contact.
- Conduct informational "briefings to industry."
- Conduct high level information "outreach" campaigns to serve as "gate openers."
- Develop listing of information repositories, e.g., Defense Technical Information Center, etc.

Industry Should:

- Work with the laboratories to develop classification and codification standards for technologies to permit development of uniform data bases, documentation, and communication between all parties.
- Individually define focused technology needs.
- Initiate contacts with federal laboratories in related fields of generic technology (technology flow is a "body contact"sport).
- Close the loop with feedback sessions.
- Conduct "pre-market" pull meetings with federal laboratories.

These should be shared with federal laboratories involved in similar generic research fields as a means for opening opportunities for joint cooperative research.

Industry and Universities Should:

- Exchange/assign scientists and engineers with federal laboratories.
- Assign facilitators to assist in technology flow.
- Provide incentives to people for technology flow.

The California Engineering Foundation Should:

- Continue the effort to sustain initiative of increasing the effective flow of technology from federal laboratories to industry.
- Become a clearinghouse (broker) to open and sustain communications between the federal laboratories and industry and to advocate the technology flow process and develop methods for identifying, assessing, and transitioning technologies from laboratories to industrial firms.
- Identify focal points and interfaces in industrial firms to receive information on federal laboratories and federally owned technology.
- Select a focused technical area and organize consortia or other joint research and development activities involving industrial firms and laboratories having common technical interests.
- Sponsor a series (few in number) of "one-on-one's" between specific laboratories and specific industrial firms.
- Brief industry R&D Directors and federal laboratory Directors on this program to assure sustained interest and support.
- Assess the status of the program in 4 to 6 months.
- Brief federal agency leaders. CEO's and state government officials on this program.

WORKSHOP 2 — PERSONNEL AND RESOURCE CONSTRAINTS

CHAIRMAN:

George Lindsteadt, Technology Utilization Office, Naval Weapons Center

PANELISTS:

Mr. Leonard Ault, NASA Headquarters

Mr. Ken Freese, Los Alamos National Laboratory

Dr. Charles Harper, Bechtel National, Inc.

Dr. Eugene Potkay, AT&T Bell Laboratories

This workshop addressed the issues associated with personnel and resources that affect the ability of both industrial firms and federal laboratories in establishing cooperative activities and transfer of technology. Large industrial firms may have their own research personnel and laboratories and have the functional capability to search for new technologies available in federal laboratories but often choose not to do so. Small firms may have the need for the technologies, have no research capability of their own, and not have the elasticity in their workforce to search for new technologies. Laboratories must give priority attention to their mission-related activities and have sufficient personnel to aggressively promote technology transfer.

Vision Statement

The federal laboratories and their sponsoring agencies are committed to transferring federally owned technology to the private sector and seeking guidance and assistance from industrial firms and consortia involved in fields of common technology. The agencies take an active role in facilitating arrangements to transfer technology between the labs and the private sector. Each federal laboratory has a separate budget and assigns personnel whose sole function is technology transfer. These personnel also track industrial needs and aggressively market laboratory capability to the private sector. Laboratories actively seek industrial cooperation and request joint projects with industrial firms. Industrial firms assign top engineers and scientists the responsibility to communicate needs to federal labs.

Constraints, Impedances, and Issues of Consideration

1. Availability of full-time experienced federal laboratory personnel assigned to technology transfer.
2. Personnel having expertise for assessment, marketing, and commercialization of technologies.
3. Level of commitment in the federal laboratories, agencies, and industrial firms to technology transfer.
4. Federal laboratory management's interest, knowledge and enthusiasm for the technology transfer mission.
5. Cultural differences between laboratories and industry.
6. Industrial personnel's "Not invented here" attitudes.

Critical Success Factors

Federal Laboratories and Agencies Should:

- Assign pro[illegible] responsibility to key personne[illegible] the purpose of technology transfer with budgeted time for the process. The staff, which must have business experience, should develop contact with industry personnel and make timely responses to industry initiated inquiries.
- Assign specific budgeted time for industry/lab cooperative activities and joint use of unique test facilities and equipment.
- Provide training programs for all laboratory personnel to assure that the commitment to technology transfer is throughout the organization, and that there is knowledge and sensitivity to technology assessment, marketing, and commercialization of technology and products.
- Develop a programmatic commitment to each technology transfer project at the very beginning of each project and provide stable funding for technology programs.
- Elevate the assignment of technology transfer to a position of stature and career enhancement. The director of each lab and agency should have the role of technology transfer in their performance plan.
- Enforce a royalty incentive system to ensure compliance to legislative mandates.
- Create an awareness of available technologies and allow industry to help decide markets for these technologies.
- Establish Industry Advisory Committees to assist in assessing the commercial value of technologies.
- Develop mechanisms to facilitate information exchange and cooperative relationships between the government and industry.

- Assign personnel to the technology transfer function who have business background and experience to assure that "market driven" assessments are made in contrast to the "mission driven" set of the laboratory.
- Designate fixed percentage of R&D budgets for technology transfer.

Industry Should:

- Assign specific job responsibility to key technical staff members to search out related generic and directly applicable technologies from federal laboratories.
- Provide budget support for personnel involved in technology transfer, including travel, per diem, etc.
- Develop policies which make the technology transfer function a requirement under all independent research and development projects wherever appropriate.
- Sponsor informational and orientation seminars for all technical personnel involved in activities such as: design, development, testing, quality assurance, manufacturing, and other endeavors related to technology to increase their awareness and commitment to technology transfer as a major option in product and process development.
- Strive toward the development of a definitive federal laboratory-to-industry technology transfer policy which will establish a cornerstone about which industry can construct its own policy.

The California Engineering Foundation Should:

- Develop materials and conduct industry seminars for industrial technical personnel to increase interest in and use of new technologies.
- Develop materials and conduct seminars for laboratory personnel to increase interest in technology transfer and awareness of industrial needs and methodologies.

WORKSHOP 3 — CONSTRAINTS — LEGAL, POLICY, SECURITY

CHAIRMAN:

Dr. Eugene Stark, Chairman, Federal Laboratories Consortium; Los Alamos National Laboratory

PANELISTS:

Mr. Dan Schneiderman, Jet Propulsion Laboratory

Mr. Harry Norton, Pacific Missile Test Center

Dr. Richard Werthamer, Becton-Dickinson, Inc.

Mr. William DeGarmo, Lawrence Livermore National Laboratory

This workshop encompassed the legal and policy-related constraints on industry/laboratory cooperation. These constraints can be real or perceived but act as impedances to effective collaboration between the federal laboratories and the private sector.

Past efforts to transfer technology or establish cooperative relationships have been stymied, in some instances, by actual or perceived policy barriers. These barriers can be in the form of bureaucratic attitudes that permit approval of only those actions that are explicitly covered by agency policy. In other cases, the unwillingness to adopt general policies that can be applied to "across the board" cases, result in a time consuming case-by-case approval system.

Vision Statement

Individual federal laboratories have the assigned authority and responsibility for effective technology transfer and are accountable for the results. A positive policy on technology transfer, backed by law, regulation, and policy, exists in all federal laboratories, departments, and their respective agencies. Intellectual property is recognized, valued, and licensed at the laboratory level, with degrees of flexibility and timeliness commensurate with industry's needs. National security issues are clearly understood, and procedures are in place to maximize the use and transfer of federally developed technology without compromising national interests.

Constraints, Impedances and Issues of Consideration

1. Legal:
   - Patents, copyrights, and licensing
   - Classification (security) of projects and technology
   - Protection of know-how, show-how, and data intellectual property
   - Biological products
   - Joint ventures, cooperative research, and property rights
   - Industry proprietary information
   - Relationships between laboratories and industry consortia
   - Fair vs equal access, and opportunity to obtain technologies
   - Liability
2. Policy:
   - Agency regulations and priorities
   - Preferential access
   - Teaming
   - Foreign access to federally owned technology
   - Inventor royalty sharing, e.g., individual vs group
   - Utilization of laboratory discretionary resources from licensed technologies
3. Security:
   - Access to facilities
   - Cooperative classified programs
   - Availability and access to classified data
   - Timeliness of decisions

Critical Success Factors

Federal Government Should:

- Commit to a sustained nonpartisan campaign to develop awareness, support, and workable policy at all levels in the executive and legislative branches in support of aggressive technology transfer.
- Modify statutory direction, as required, to departments, agencies, and laboratories to assure that the technology transfer mission for utilization of federally owned technology in the private sector is aggressively implemented.
- Adopt uniform contract and licensing practices to facilitate the formal transfer of technology that can be protected under intellectual property laws.
- Reexamine and modify law, regulations, and policy to maximize the effectiveness of industry/government sponsored independent research and development.
- Protect national security by a timely case-by-case review of documents.
- Adopt regulations and policies which provide control of classified technology as required for national security and yet does not over-classify technology and which expedite the disposition of nonsensitive technologies to the private sector.

- Prepare a definition of "foreign industry" to assist the laboratories in providing preference to American industry.
- Remove Agency discretion in interpretation of patent laws.
- Assign authority and responsibility for technology transfer to the individual laboratories.
- Develop an initiative modeled on the SBIR (Small Business Innovation Research, National Science Foundation) program. Allocate funds to businesses for investment in federal laboratories — for which the labs would compete.
- Ask the laboratories to assess their technology transfer performance on a regular basis.
- Make technology transfer a clear part of every agency and laboratory mission.
- Develop a set of technology transfer success factors, e.g., licenses, royalties, cooperative agreements, business spin-offs, and nonmonetary returns.
- Make technology transfer expenditures an allowable laboratory cost/expense.
- Permit agencies to retain, for mission purposes, royalty receipts that would otherwise be remitted to the U.S. Treasury.
- Consider issues related to the government's royalty free license in certain cases: e.g., those inventions that will have military applications before commercial applications. The objective would be to preserve some needed exclusivity to the firm(s) risking investments in later commercial applications.
- Make technology transfer a factor in administrators personnel performance standards.

Industry Should:

- Develop a unified approach for the protection of proprietary information and technology resulting from joint industry/laboratory cooperative research.
- Modify corporate employee intellectual property assignment agreements to make them similar to those developed for federal laboratory staff personnel to provide royalty sharing in inventions developed through joint research projects with federal labs.

The California Engineering Foundation Should:

- Strengthen technology transfer within the federal laboratories by providing regular or case-by-case awards to laboratories for highly effective technology transfer programs.
- Act as a coordinating body and Systems Projects Office (SPO) to develop coalitions and support for an aggressive federal technology management national policy at all levels.
- Assist industry in identifying policy and regulatory constraints in the federal laboratories that are impedances to efficient technology flow and assist in effecting changes.
- Develop a uniform perspective of industrial needs for technology in order to provide federal laboratories a better understanding of industrial requirements.

WORKSHOP 4 — MOTIVATION — LABORATORIES AND INDUSTRY

CHAIRMAN:

Dr. Robert Moore, Senior Research Associate, Chevron Research Company

PANELISTS:

Mr. Lawrence Milov, NASA Ames Research Center

Mr. Charles Miller, Lawrence Livermore National Laboratory

Ms. Carolyn McClain, Scientific Computer Systems

Mr. David Herting, The MacNeal-Schwendler Corp.

This workshop examined the motivational factors that impact technology transfer from federal research laboratories into commercial products and processes. Discussion was focused on internal motivation, priorities, and measures of success for federal vs industrial research and development; specific examples of successful and unsuccessful technology transfers; and key motivators and de-motivators for the technology transfer process. The realistic prospectus for a continuous technology transfer process was evaluated and recommendations were developed for motivating a successful and continuous process of technology transfer from federal laboratories to industrial companies.

Vision Statement

The federal government owns and operates a multiplicity of technical research laboratories throughout the nation and devotes significant public funds for basic and applied research and exploratory development in the full spectrum of technologies to meet national needs. Federal departments, agencies, and laboratories are strongly motivated under existing laws, to transfer federally owned technologies to the private sector. These motivations are both direct, through royalty sharing arrangements from licensing, and indirect through recognition, awards, and promotional practices. Industry is strongly motivated to seek collaborative pursuits of commercially applicable technology with the laboratories as a means for reducing costs, increasing knowledge, and securing a competitive edge in both the domestic and international markets.

Constraints, Impedances, and Issues of Consideration

1. Dissimilarities between the primary drivers for federal and industrial research and development (large vs small federal laboratories and large vs small industrial firms) in light of mission and program objectives:
   - criteria for success
   - cost and time impacts and offsets
   - profit
   - exclusivity
   - proprietary protection
   - competitive edge
   - funding policies for technology transfer
2. Allocation or diversion of resources to acquire or transfer technology.
3. Federal laboratory flexibility and independence of operation, vis-a-vis federal departments and agencies.
4. Federal laboratory budget augmentation with discretionary resources from royalty sharing licensing arrangements.
5. Entrepreneural opportunities for federal laboratory research personnel.
6. Recognition, reward, growth and career opportunities.
7. Leverage of new technology in leap-frog development.
8. Discretionary (targeting) vs general technology transfer.
9. Disruptive and diversionary effects of new technology on established product and process lines.
10. Laboratory primary mission vs technology transfer objectives.
11. Market implications for new technologies.
12. Risk venture capital implications.
13. Motivational misperceptions on applicability of federally owned technology in private sector industry.

Critical Success Factors

Federal Laboratories Should:

- Develop and adopt significant "payoff" criteria, that motivate senior, middle management, and research scientists, to aggressively promote the transfer of federally owned technology into the private sector.
- Allocate a measurable level of effort supported by budget line items to the technology transfer mission separable from the research mission of the laboratory.

- Adopt, implement, and widely publicize policies which clearly recognize and reward laboratory researchers, management, and supervisory personnel for successful technology transfer, and in some cases, entrepreneural efforts associated with federally owned technology.
- Develop an external alternative constituency to support technology transfer.
- Develop and implement a proactive strategy of information and technology transfer manifested by a strong demonstrated commitment by laboratory management.
- Develop a coordinated effort to stimulate federal agencies to adopt policies which make technology transfer an integral component of the laboratories' missions.
- Develop a chain of responsibility within the labs to effect the technology transfer mission and conduct programs to educate laboratory personnel of their methodologies and roles to implement the process. The education should make the personnel aware that technology transfer is not a give-away of public property nor does it cause an anticompetitive effect within U.S. industry.

Industry Should:

- Develop industrial relations policies and practices which recognize and reward senior and middle management as well as technical personnel to actively search for, acquire, and utilize federally owned technology.
- Allocate specific budget commitments and assignment of personnel to facilitate technology transfer.
- Provide support for technical personnel to attend technical symposia, visit federal laboratories, and establish working relationships with their counterparts in federal laboratories to increase their awareness of technologies that can be transferred.

The California Engineering Foundation Should:

- Widely publicize the importance of technology transfer and examples of successes resulting in new business and product development.

ACTION PLAN

Background

The California Engineering Foundation's interest and involvement in the broad field of technology transfer dates back to the inception of the Foundation. The first project conducted by the CEF was a four-day conference on science and technology policy and an eight-day exposition on technology, held in 1976. The CEF conducted studies in 1978 and 1979 examining methods for assisting the development of new products and enterprise. In conjunction with these efforts, the California Legislature developed legislation that proposed the creation of the California Product Development Corporation — a quasi public entity dedicated to assisting entrepreneurs in the transfer of technology and innovation of new products and enterprise. The CEF was asked to provide expert testimony in a legislative interim hearing on the subject. Although the legislation did not pass, the Foundation increased its image as a source of clinical information on the subject.

CEF sponsored public expositions in 1982 and 1984 in conjunction with the California State Fair that highlighted a broad spectrum of technologies. In both cases, the CEF involved the U.S. Patent and Trademark Office. Preliminary patent searches were made possible through direct computer access to some of the major data bases in the U.S. and England. The CEF maintains liaison relations with the Patent Office.

Liaison relations have been established with key offices in the U.S. Department of Commerce responsible for productivity, technology, innovation, and federal technology management. The CEF was asked to provide technical assistance to Congressional staff when the legislation that created the Federal Technology Transfer Act was moving through the process.

Finally, CEF has worked with representatives from California-based federal laboratories in its conferences on engineering education, competitiveness, technology transfer, and economic development in programs conducted over the past four years.

After passage of the Federal Technology Transfer Act, the CEF established a national task force on federal technology transfer made up of representatives from industry, agencies, and federal laboratories. The task force is being expanded to increase industrial membership.

Objectives

Increased use of federally owned technology is a matter of national policy that presents a strategic challenge. The primary objective of this action plan is to analyze the results of the Forum on Federal Technology Transfer, develop a CEF strategic plan and tactical plans and begin the implementation process. The CEF program is national in scope but will utilize, to the extent possible, learning experiences gained at the local, state, and regional levels to project national considerations. Since there are 38 large and small federal laboratories in the state, statistical representative modeling is valid. Program resources limitations necessitate concentrating efforts in ways that minimize logistical complexities. However, laboratories and industrial firms outside of California are invited to participate to the level they desire.

Planned Program

1. Documentation and Dissemination

The findings of the Forum are documented in this report. They will be disseminated to the Forum attendees, key offices in industry, federal laboratories, state governments, federal agencies, educational institutions, and technical, trade, and professional organizations. The Economic Development Administration of the U.S. Department of Commerce has provided a small grant to assist in this process.

2. CEF Task Force Plan

The CEF task force will be expanded to increase industrial representation. It will be used as a sounding board for the preparation of tactical plans, instrumental in the expansion of the communications network, directly involved in the implementation of action plans, and a key element in the development of program functional capability. Findings from the Forum will be analyzed to further define the role to be played by the CEF in coordination and systems management. Some of the tactical actions that should be taken by the CEF, based upon the constraints and critical success factors, have been included in the critical success factors sections of the four workshop summaries.

3. Functional Capability

The CEF is a fully exempt nonprofit corporation that receives its support from grants, contracts, and contributions to permit program development and execution. The effectiveness of the action program and path forward will depend completely upon the level of support that the Foundation receives from the public and private sources. Both have a vital interest in the long-range program objectives. The federal laboratories have a statutory mandate to increase their effectiveness in technology transfer, and the industry has an incentive to utilize technology that has been developed at public expense.

Because of the complex nature of the challenge and the fact that there is no quick and simple solution to the implementation of the Act, the project must have a commitment of support for at least three years. The estimate for a minimum level of funding is $150,000 per year. A higher level of support will permit a more comprehensive program that addresses additional constraints and impedances.

Funding and in-kind support should be provided by the federal agencies and their laboratories, private foundations, industrial firms, and state governments. The degree of support and commitment that is demonstrated by all interested parties will determine the level of effort that the CEF can commit to the program.

4. Invitation for Involvement

The CEF invites all interested parties who wish to participate in this program to become actively involved. Options include: membership in the CEF task force, participants in forums and workshops, and contributors of resources and in-kind services.

Conclusion

The ability of the U.S. to compete effectively in the world market will be determined by how well domestic firms compete in the domestic markets. The U.S. Department of Commerce has said that technology fuels the engine of commerce. How efficiently the U.S. uses this fuel for developing new products, increasing productivity of existing industries, and generating new enterprise will set the course of history. Standard of living, quality of life, and national sovereignty are at risk. It is axiomatic that "business as usual" is not a viable option to address any of these three critical parameters. One thing is certain. Changes from past methodologies must take place to succeed in the emerging world economy. The nation will either control its destiny by managing for that change or it will be impacted by change imposed by others.

The CEF is dedicated to the efficient development and utilization of technology to foster economic development and increase the nation's competitive edge. The ability of the CEF to carry out its mission to serve the state and nation will be determined by the level of commitment and support provided by those desiring to address these challenges.

TASK FORCE ON FEDERAL TECHNOLOGY TRANSFER

Joseph P. Allen
Director, Federal Technology Management, U.S. Department of Commerce

Dr. Kess Alley
Vice President, Refin. and Prod. Research, UNOCAL

Leonard A. Ault
Technology Utilization Division
NASA Headquarters

Dr. Alan Bennett
Vice President, Research
Varian Associates, Inc.

Donald I. Carter
Director, Aerospace and Elect. Tech., Rockwell International Corporation

Dr. Richard Claassen
Vice President (Retired)
Sandia Corporation

D. M. Delabarre
FLC Administrator,
Delabarre & Associates, Inc.

Pat Hill Hubbard
Vice President, Engineering Education and Management Programs, American Electronics Association

Dr. Harold H. Klepfer
President
Exec Tech, Inc.

Robert J. Kuntz
Executive Director and C.E.O., California Engineering Foundation

Charles F. Larson
Executive Director, Industrial Research Institute

Dr. Frederick C. Leavitt
Director Government Science Relations, Dow Chemical Company

Dr. Richard Lee
Vice President, Res. and Development, American Pharmaseal Co.

George F. Linsteadt
Technology Utilization Office, Naval Weapons Center, MC 01T3

Gordon T. Longerbeam
Program Leader, Technology Transfer Initiatives, Lawrence Livermore Nat. Laboratory

Dr. Joseph Longo
General Manager, Science Center, Rockwell International Corporation

Eli March
Chief, Technical Assist. Branch, U.S. Dept. of Commerce, E.D.A.

Jerold A. Meyer
President, Chevron Research Company

Charles Miller
Technology Utilization Office, Lawrence Livermore Laboratory

Lawrence Milov
External Affairs and Techology Transfer, NASA Ames Research Center
MS 223-3

Dr. Wayne Pitcher
Vice President, Development, Genecor

Lee Rivers
Washington Representative, Federal Laboratory Consortium

Debra M. Amidon Rogers
Manager, U.S. Sponsored Research, Digital Equipment Company

Dr. Loren Schmid
Far West Coordinator, FLC, Pacific Northwest Laboratory

Dr. Eugene Stark
Chairman, Federal Laboratory Consortium, Los Alamos Scientific National Laboratory

Dr. Arthur C. Thorsen
Senior Research Executive, Science Center, Rockwell International Corporation

Terry Vaeth
Assistant Manager, Defense Programs, San Francisco Operations, U.S. Department of Energy

Dr. Richard C. Wayne
Director, Component Systems Research, Sandia National Laboratories

CALIFORNIA FEDERAL LABORATORIES

Lawrence Livermore National Laboratory, U.S. DoE, Livermore, CA
Charles Miller
(415) 422-6416
Nuclear Physics, High Pressure, Lasers, and Surface Science

Ames Research Center, NASA, Moffett Field (Mountain View), CA
Stan Miller
(415) 965-6471
Fluid Mechanics, Planetary Science, Life Science, Aeronautics

Naval Weapons Center, U.S. DoD, China Lake, CA
George Linsteadt
(714) 939-1074
Air Warfare Systems, Missile Systems

Flight Test Center, U.S. DoD, Edwards AFB, CA
P. J. Conley
Aerospace Research/Testing

Jet Propulsion Laboratory, NASA, Pasedena, CA
Gordon Chapman
(213) 354-8300
Multidisciplinary Research, Astronautics, Planetary Research, Satellite Tracking

Lawrence Berkeley Laboratory, U.S. DoE, Berkeley, CA
Robert Morris
(415) 486-6502
Multidisciplinary Research

U.S. Geological Survey (Western Region), U.S. Department of Interior, Menlo Park, CA
Georgy Gryc
(415) 323-8111
Geology, Geophysics, Water Resources

Naval Ocean Systems Center, U.S. DoD, San Diego, CA
Dr. Richard November
(619) 225-6281
C-3, Ocean Surveillance, Weapon Systems for Sub/Arctic Warfare

Stanford Linear Accelerator Center, U.S. DoE, Menlo Park, CA
Herman Murphy
(415) 834-3300
Nuclear Physics, Synchrotron Radiation

Hugh Dryden Flight Research Center, NASA, Edwards AFB, CA
John Mathews
Aeronautics and Flight Research

Naval Civil Engineering Laboratory, U.S. DoD, Port Hueneme, CA
Jerry Dummer
(805) 982-4070
Engineering (Civil, Mechanical, Electrical, Earthquake) Environmental Research, Energy, Oceanographic Research

Western Space and Missile Center, U.S. DoD, Vandenberg AFB, CA
Launch Operations

Naval Personnel Research and Development Center U.S. DoD, San Diego, CA
Robert Turney
(619) 225-7424
Management Training

Aviation Research and Technology Laboratory, U.S. DoD, Moffett Field, CA
Army Airmobile Research and Development

Astronautics Laboratory (Rocket Propulsion Lab), U.S. DoD, Edwards AFB, CA
Ms. Chris Degnan
(805) 277-5014
Rocket Propulsion Technology

Letterman Army Institute of Research, U.S. DoD, San Francisco, CA
Jack Keller
(415) 561-2641
Medical Research, Development, and Technology and Evaluation

Laboratory of Biomedical and Environmental Sciences, U.S. DoE, Los Angeles, CA
William Moffitt
(213) 825-9431
Energy Related Medical, Biomedical, and Environmental Research

Energy Technology Center, U.S. DoE, Canoga Park
Guy Ervin
(818) 700-5532
Analytical Chemistry, Metalography, Reactor Components Technology

Southwest Fisheries Center and Associated Laboratories, U.S. Department of Commerce, La Jolla, CA
John Carr
(619) 453-2820
Marine Research, Ocean Research

Sondrestrom Radar Facility (SRI International), National Science Foundation, Menlo Park, CA, Radar Facilities for Thermospheric/Ionospheric Research

Aviation Engineering Flight Activity, U.S. DoD, Edwards AFB, CA
Flight Testing

Naval Health Research Center, U.S. DoD, San Diego, CA
Lt. Kenneth Steel
(619) 225-2911
Medical and Psychological Aspects of Health and Performance

Western Human Nutritional Research Center, U.S. Department of Agriculture, San Francisco, CA
James Iacono
(415) 556-9699
Human Nutrition

Government-Industry Data Exchange Program, U.S. DoD, Corona, CA
William Arnitz
(714) 736-4677
Provides mechanisms for data exchange related to life cycle of equipment and systems

Laboratory for Energy Related Health Research, U.S. DoE, Davis, CA
Marvin Goldman
(916) 752-1341
Health and Environmental Effects of Radiation and Fossil Fuel Effluents

Rehabilitation Research and Development Center, U.S. Veterans Administration, Palo Alto, CA
Larry Leifer
(415) 493-5000
Medical

Laboratory of Radiobiology and Environmental Health, U.S. DoE, San Francisco, CA
Dr. Sheldon Wolff
(415) 666-1636
Medical Research

Artificial Intelligence in Medicine, U.S. Department of Health, Stanford, CA
Thomas Rindfleisch
(415) 497-5569
A.I. Applications in Biomedical Science

NASA Industrial Applications Center, NASA, Los Angeles, CA
Herb Asbury
(213) 743-6132
Provides searches of computorized bibliographic databases

Metal-Matrix Composites Information Analysis Center, U.S. DoD, Santa Barbara, CA
Louis Gonzages
(805) 963-6482
Collects and disseminates information of MMC's

Geothermal Test Facility, U.S. DoE, San Francisco, CA
A.J. Adduci
(415) 273-7942
Tests Geothermal and Related Equipment

Pacific Missile Test Center, U.S. DoD, Point Mugu, CA
Dan Kimsey
(805) 989-7124
Test and Evaluation of Missile Systems and Components

Naval Postgraduate School, U.S. DoD, Monterey, CA
Dr. Dan Boger
(408) 646-2607
Multidisciplinary Research

Western Regional Research Center, U.S. Department of Agriculture (Various locations and contacts)
DoA operates over 30 research units in the state dealing with a multitude of agriculture research fields of study

Sandia National Laboratories, U.S. DoE, Livermore, CA
Dr. Richard C. Wayne
(415) 294-2711
Nuclear Physics, Combustion Research

ATTENDEES

Jack Andresen
President, Electronic Transformer Service

Leonard A. Ault
Deputy Director, Technology Utilization, NASA Headquarters

Michael L. Bandler
Vice President, Network Engineering/Planning
Pacific Bell

Dr. Alan Bennett
Vice President, Research
Varian Associates, Inc.

E. Steuart Bjornsson
Chairman, IEEE Intellectual Property Committee

Dr. Barbara Bowen
Apple Computer

Nick Broderick
E.G and G.

E. M. Brodie
Westinghouse Electric Corporation

Rob Brownstein
Vice President, Regis McKenna, Inc.

Donald I. Carter
Director, Aerospace and Elect.Tech., Rockwell International Corporation

Michael A. Chartock
Lawrence Berkeley Laboratory

Dr. Lloyd Chase
Lockheed Missile and Space Company

Dr. Budd C. Cohen
Consultant, TRW Inc.

Col. Gordon G. Davis
U.S. Astronautics Laboratory

William C. DeGarmo
Lawrence Livermore National Laboratory

D.M. DelaBarre
FLC Administrator
DelaBarre and Associates

Floyd E. Dunn
Sales Manager, Education
Scientific Computer Systems Corporation

Dr. Donald M. Fenton
Senior Research Scientist
UNOCAL

Kenneth Freese
Los Alamos National Laboratory

Abraham Furman
Pacific Hemostasis

N. Wayne Green
Fluor Daniel, Inc.

Dr. Charles A. Harper
Bechtel National, Inc.

Daryl G. Hatano
International Trade and Government Affairs
Semiconductor Industry Association

Douglas Henton
Policy Research Analyst
SRI International

David N. Herting
The MacNeal-Schwendler Corporation

Dr. Donald J. Holve
Insitec

Patricia Hubbard
Vice President, American Electronics Association

Diana Jackson
Naval Ocean Systems Center

Frank Jelenko
NEC Electronics

Joseph Jineff
Peterbilt Motors

Richard Kazares
Central Engineering Laboratories, FMC Corporation

William A. Klabunde
Northrop Corporation

Dr. Harold H. Klepfer
President, Exec Tech., Inc.

Cordell Koland
San Jose Business Journal

Martha Krebs
Lawrence Berkeley Laboratory

Robert J. Kuntz
Executive Director and C.E.O., California Engineering Foundation

Glen Kuswa
Sandia National Laboratory

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Aerojet TechSystems Company

Dr. Paul Lawrence
Litmus Concepts, Inc.

Thomas Lee
Aehr Test Systems

Dr. James Ling
President, Ling Technology Associates, Inc.

George F. Linsteadt
Naval Weapons Center

Joseph G. Logan
Director, Urban University Center, University of Southern California

Gordon Longerbeam
Technology Transfer,
Lawrence Livermore National Laboratory

Dr. Joseph T. Longo
Vice President and General Manager, Science Center
Rockwell International

Robert E. Lorenzini
REL Capital

Eli P. March
Director, Technical Assistance, Economic Development Administration, U.S. Department of Commerce

George Marquis
Kaiser Engineers

Joseph W. Martinelli
General Manager
Engineering Department
Chevron Corporation

Carolyn McClain
Scientific Computer Systems Corporation

Curt W. McGee
Kaiser Engineers

Charles R. McGinnis
Chief Project Manager, Eng. Dept., Chevron Corporation

Thomas P. Miles
ARGO Systems, Inc.

Charles Miller
Technology Transfer,
Lawrence Livermore National
Laboratory

Lawrence Milov
Director, External Affairs
and Technology Transfer,
NASA Ames Research
Center

Don R. Mittlestaedt
The Clorox Company

William Moffat
RADCOM

Robert M. Moore
Senior Research Associate
Chevron Research Company

John Morrison
Northern Telecom

Asok K. Mukhopadhyay
AKM Associates

Harry Norton
Technology Transfer
Representative
Pacific Missile Center

Janet L. Owen
Bechtel National, Inc.

Doyle Patrick
Special Projects
Pacific Bell

Dr. Wayne Pitcher
Vice President, Development
Genecor

Dr. Eugene Potkay
AT&T Bell Laboratories

Lee W. Rivers
Washington D.C.,
Representative, Federal
Laboratories Consortium

Dr. Edwin B. Royce
Naval Weapons Center

Dr. A. H. Sacks
Rehabilitation R&D Center
Veterans Administration
Medical Center

Dan Schneiderman
Jet Propulsion Laboratory

Douglas Schwandt
Rehabilitation R&D Center
Veterans Administration
Medical Center

Michael R. Sheptak
Manager, Engineering Design
AMPEX

P. Martin Simpson
Lawrence Livermore National
Laboratory

Dr. Eugene Stark Jr.
Chairman National Federal
Labs Consortium, Los
Alamos National Laboratory

Ira G. Stoltzfus
District Manager, Air
Products and Chemicals Inc.

Dr. Robert Storer
Naval Civil Engineering
Laboratory

George R. Thomas
U.S. Army Material
Technology Laboratory

Dr. Arthur C. Thorsen
Senior Research Executive,
Science Center, Rockwell
International Corporation

Gary Titzer
Manager, Special Projects
Pacific Bell

Terry Vaeth
Deputy Assistant Manager for
Energy Res., U.S.
Department of Energy

John Vostrez
CALTRANS

Dr. Thomas Walters
Technology Transfer
Jet Propulsion Laboratory

Dr. Richard C. Wayne
Sandia National Laboratory

Richard Wertheimer
Becton-Dickinson &
Company

Andrew C. Wiktorowicz
Division Manager
Nova Power, Inc.

Ward Winslow
President, Winslow Writing

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